POWER

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Index to Advertisers, 45.

MAR 13 1912

It sounds rather large when mechanical engineers tell us that 20% of the power developed is sometimes lost by slipping belts, but this they say often happens. With proper belting, however, much of this loss can be saved. Tannate Leather Belting saves a large part of it. There is more than one reason, but the most obvious one is its grip. If you feel the soft, clinging surface you will see this. You could hardly make a Tannate Belt slip if you wished. Another reason is its pliability. This makes it hug the pulley close, giving efficient contact.

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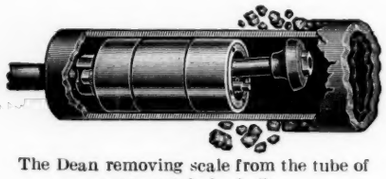
> *"You win. Today we took 825 pounds of scale from a boiler we thought clean. Please send bill."*

A concern in Cleveland, Ohio, thought boiler compounds were solving their scale problem. Because they

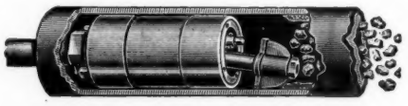


The Dean removing scale from the tube of a return tubular boiler.

were willing to give the Dean a trial they are *now saving* $50.00 a month. Note what they say:

> *"The cleaner is working very satisfactorily indeed and we have discontinued the use of boiler compound, which was costing us in the neighborhood of $50.00 per month."*

One of the largest corporations in the Country was looking for the *best* tube Cleaner for water tube boilers. Everybody around the plant said the best way to clean a water tube was to bore



The Dean removing scale from the tube of a water tube boiler.

out the scale. One man said: "It won't hurt to try the Dean; why not try it with the others?" So they tried it. Here's what the Superintendent wrote after all the Cleaners had been tested:

> *"We find that your Cleaner has given better satisfaction than any cleaner for water tubes we have tried. We have experimented with several different cleaners this spring and yours has given us the best results. It cleans the tubes more thoroughly than any we have tried."*

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Per .....
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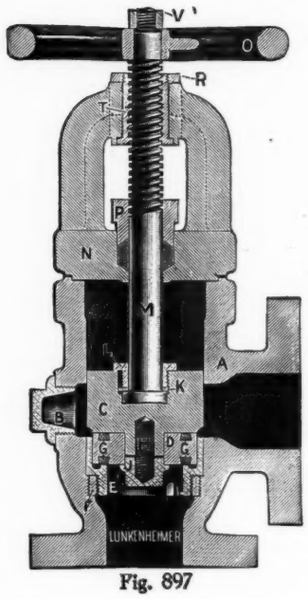

Fig. 897

Lunkenheimer "Duro" Blow-Off Valves

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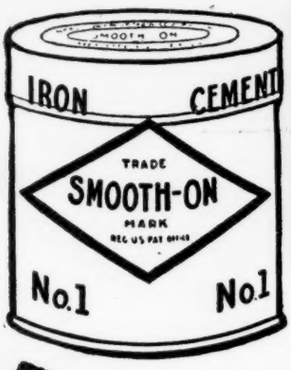

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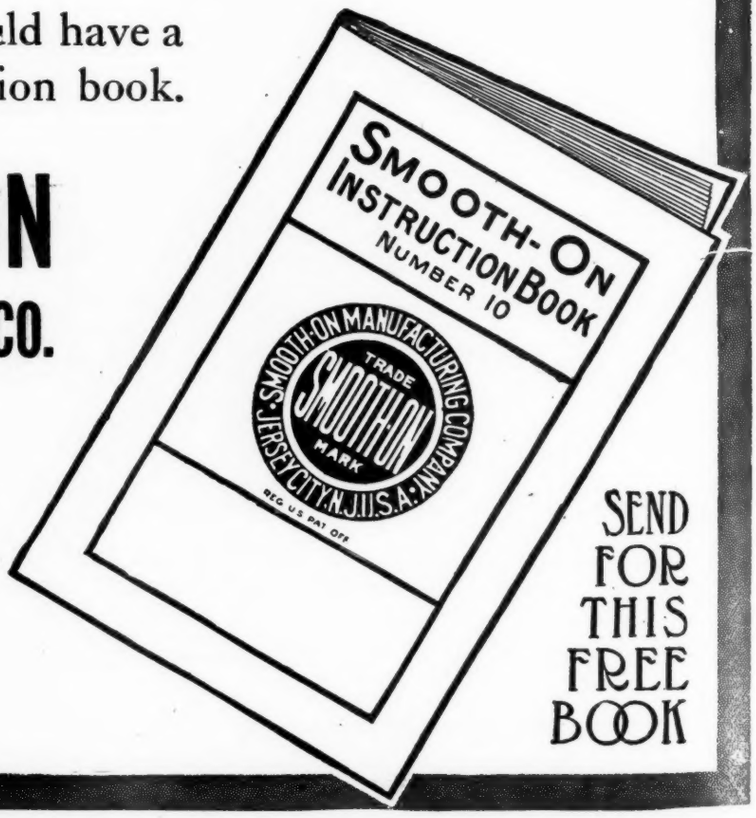

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POWER

Vol. 35 NEW YORK, MARCH 12, 1912 No. 11

We have some thirty thousand subscribers scattered all over the country. It ought to be impossible for anything of general interest in the power-plant line to happen without our getting quick knowledge of it. No such thing could happen if any large proportion of our readers would consider themselves a part of the POWER family and if each, when anything happened in his neighborhood that seemed to be of more than local interest, would drop us a line, or telegraph at our expense if the importance of the event warrants.

What a power we could be if we had a lookout in every town!

We do not expect such service for nothing. We try to make any effort exerted for us worth while.

Don't let anything stop you. Be the first to send the news.

It is not to us that the service is rendered. It is through us to the power-plant owners and engineers of the country. They pay us and we pay those who help.

We do not expect finished articles. We want the news, facts, ideas. If every time a boiler explodes, or a flywheel bursts, somebody would even telegraph us that it had happened we could follow up the clue and assemble here statistics of such casualties that would be extremely valuable for use in arguments for remedial legislation.

We could draw from such of them as offered the material, engineering lessons upon the design, construction and operation of such apparatus that would help avert further catastrophes.

We should like to know of new power plants and of important extensions to existing installations.

We should like to know of changes in position by prominent engineers, of important papers presented to engineers' societies, of new things proposed for power-plant use, whether these promise to be of real value or are of the too frequent fallacious or fraudulent variety.

Won't you take this to yourself, and the next time you learn of anything that you think POWER readers would be interested in, send it to us. You will be doing the engineers a service, and we will see that your trouble is not lost.

Hazard M'f'g Co.'s New Power Plant

By Warren O. Rogers

An ideal station supplanting several steam engines scattered throughout the factory.

Individual motor drive will be used on the wire rope making machinery.

Originally, the Hazard Manufacturing Co., Wilkes-Barre, Penn., following the practice of the day, had its several steam engines used in the manufacture of wire rope, insulated wire and cables, etc., located at convenient points in the factory and adjacent to the machines which they were to drive.

Some of these engines are in use at the present time, but their days are numbered and they will soon be displaced by electric motors, which will obtain electrical energy from the generators in the new power plant that has recently been constructed; much of the machinery in the factory has already been changed to motor drive.

The engine room is 40 ft. wide, 92 ft. long and 30 ft. high from the floor to the trusswork which supports the roof, which is sheathed with 2½-in. planking and covered with asphalt and gravel. The room is made exceptionally light by the large amount of window area. The floor is made of 2½-in. flooring and this is covered by 1-in. hard maple, upon which strips of Scotch linoleum are laid where the greatest wear takes place.

Engines and Generators

At present there are two 22x36-in., four-valve, double-eccentric Corliss engines installed, each of 328 amperes capacity, and run at 120 r.p.m. Each engine is connected to a 250-kw. alternating-current generator, which delivers electrical energy to the switchboard at 440 volts. This voltage permits of operating the motors in the factory without the use of transformers. Where lights are installed using a lower voltage, the transformers are placed in a fireproof vault built in that part of the factory in which the motor is located. All wires are placed in iron-pipe conduits, and all switches and fuses are confined in an asbestos-lined wood or metallic box.

Both generators are run in parallel without difficulty. Each engine is equipped with a special flywheel 16 ft. in diameter, the extra weight in the flywheel assisting in the regulation. Fig. 1 shows a view of the engine room.

Auxiliaries

The other machinery in the engine room consists of a belt-driven 125-volt exciter generator and an induction motor driving a direct-current 250-volt generator. The latter unit is used for supplying direct current to the factory for elevator and crane service.

Switchboard

The switchboard is placed at one end of the engine room and is made up of seven marble panels, two of which are for the generator control, three dis-

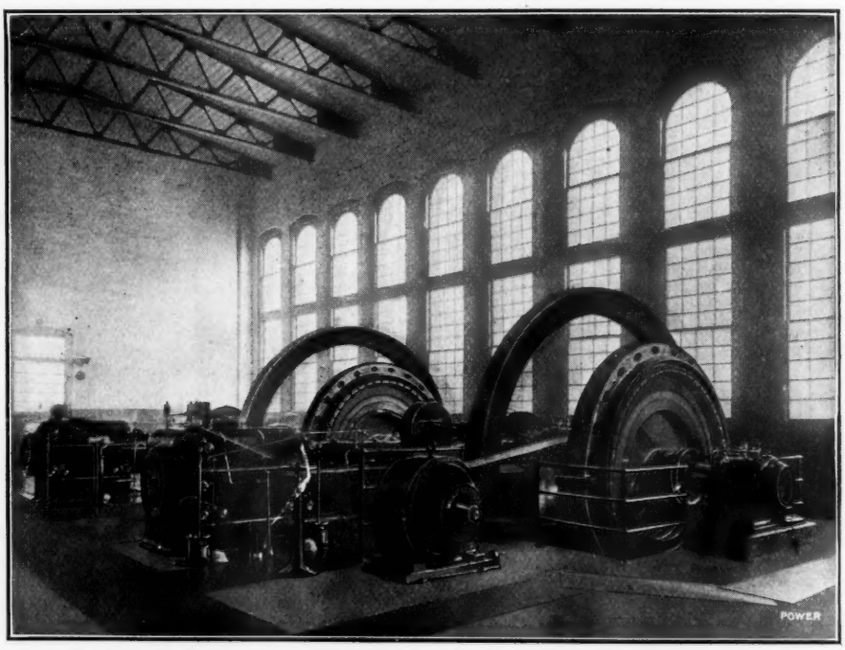


Fig. 1. New Engine Room of the Hazard Manufacturing Co.

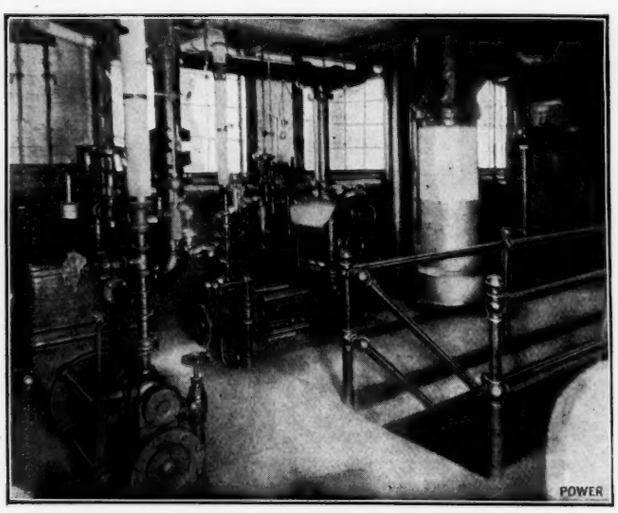


Fig. 2. Vacuum Pumps on Heating System

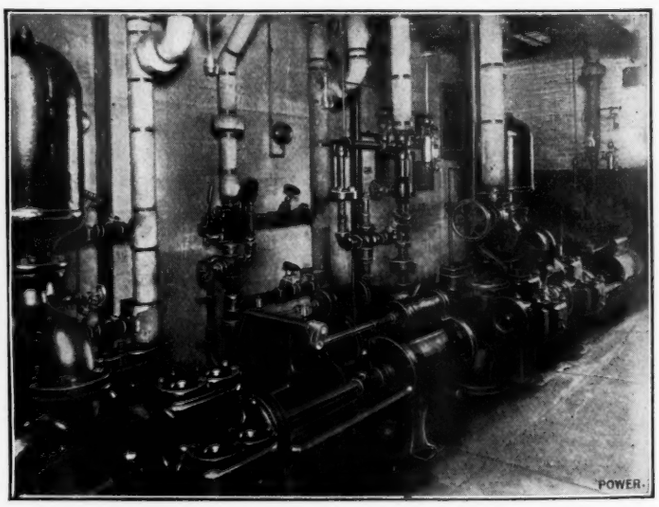


Fig. 3. Boiler-feed Pumps

tributing panels and two instrument panels. Double busbars have been provided so that in case the motor load causes fluctuations in the lighting circuit the motor and lighting circuits could be handled separately from the two busbars. Under present conditions, however, both services are taken from the same busbar. The power factor ranges between 80 and 85. There is floor space for an additional unit of double the capacity of either of the single engines.

Boilers

In the boiler room, Fig. 4, there are four 308-hp. water-tube boilers. They are set with two boilers in a battery, and a steam pressure of 100 lb. per square inch is carried. No. 2 buckwheat coal is burned with the aid of forced draft, which varies from ½ to 1 in., according to the thickness and condition of the fires. The forced-draft fan is located in the pump room beside the brick stack. The air is forced through the ashpit of each boiler and through a 44-in. galvanized-iron air duct, which tapers from an end section 75 in. in diameter at the fan connection. The fan is 10 ft. in diameter, 5 ft. wide and is driven by a small steam engine that is automatically controlled by a damper regulator, which operates a butterfly throttle valve. The gases of combustion pass from the combustion chamber of the boilers to a brick smoke flue constructed under the rear end of the boilers. This smoke flue is 9 ft. wide and 7 ft. 6 in. high, with the roof curved at a 9-ft. radius.

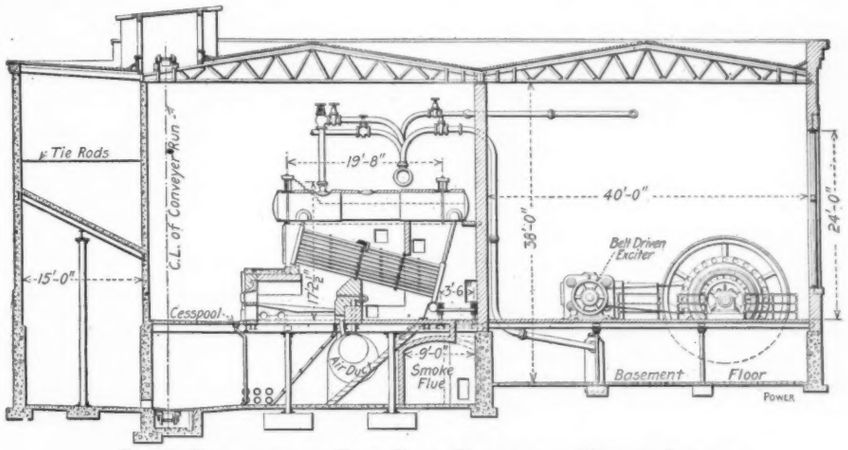


Fig. 5. Elevation of Coal Bins, Boiler and Engine Rooms

The smoke connection between the combustion chamber of each boiler is 2 ft. 6 in. wide and 10 ft. long. The smoke flue extends along the back of and under the boiler to a brick stack which is 125 ft. high and 10 ft. and 13 ft. inside and outside diameter respectively at the bottom, and 8 ft. and 9 ft. 2 in. inside and outside diameter respectively at the top.

Aside from the forced draft, each boiler is fitted with a steam blower and a shaking and dumping grate, each furnace having 10x10-ft. grate surface. The blowers are not used while the air fan is in operation, but are an auxiliary feature in case the fan arrangement becomes deranged. The boilers are equipped with dutch-oven furnaces and hand firing is used. Exhaust steam from the fan engine is passed to the ashpit of the boilers to assist in preventing the formation of clinkers.

The boiler furnaces are designed to burn the finer sizes of anthracite coal. Another feature is that the clean-out doors in the side walls are hinged at the top so that in case of gas explosion the doors will be blown out at the bottom and, swinging on the hinge, damage to the boiler fittings is avoided.

The mud drum of each boiler is fitted with two 3-in. blowoff pipes which connect with the main 8-in. blowoff pipe. This permits the steam to expand before it passes to the sewer. A trap is formed between the sewer and the boilers by a drop leg, cross-section and a riser pipe, the latter discharging to the sewer.

Coal is delivered to the coal bins by a bucket conveyor and the ashes are handled by the same conveyor. The fuel is dumped on the firing floor from the coal bins after it has passed through a coal weigher.

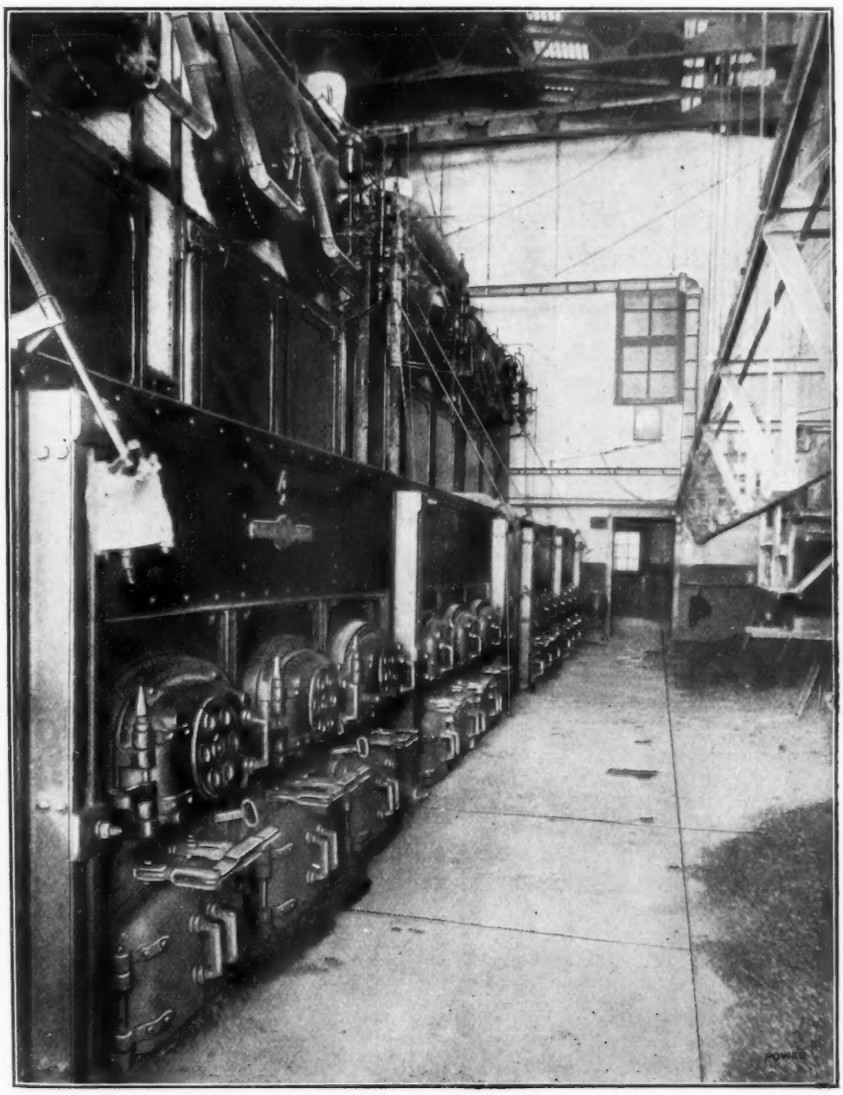


Fig. 4. New Boiler Room, Showing Dutch Oven Construction

Pumps

Two 10 and 7 by 18-in. outside-packed pumps supply feed water to the boilers, taking the water from an open heater at a temperature of between 210 and 212 deg. F. The boiler-feed pumps, shown in Fig. 3 are made with a long stroke, thus avoiding frequent reversal in the piston travel.

Exhaust steam is used in the factory-heating systems, but when exhaust steam is not available, such as holidays and Sundays, live steam is reduced from boiler pressure to between 25 and 30 lb., after which the steam passes through a second reducing valve and goes to the factory at a pressure of ½ lb. per square inch. The returns are taken care of by two vacuum pumps, shown in Fig. 2.

Piping

In Fig. 5 is shown an elevation of the boiler and engine rooms and illustrates the design of some of the more important pipe lines. Fig. 6 is a plan view. Each boiler is connected to an 18-in. steam header by an 8-in. steam pipe. The connection between the header and each engine is made with an 8-in. pipe which extends just through the wall between the boiler and the engine rooms and then drops to the basement; then it runs across to the engines. The steam passes through a separator which is placed in the engine-room basement.

The exhaust pipes from each engine are each 10 in. in diameter and connect with a 20-in. exhaust main.

The exhaust steam passes to a feed-water heater and either escapes to the atmosphere in warm weather or is exhausted to the heating system during cold weather. All steam piping is fitted with steel flanges tested to 250 lb. pressure per square inch.

The boiler-feed pipes are fitted with Y-valves when possible and are made of brass.

Several interesting features of this plant will be treated in a separate article which will be published in an early issue.

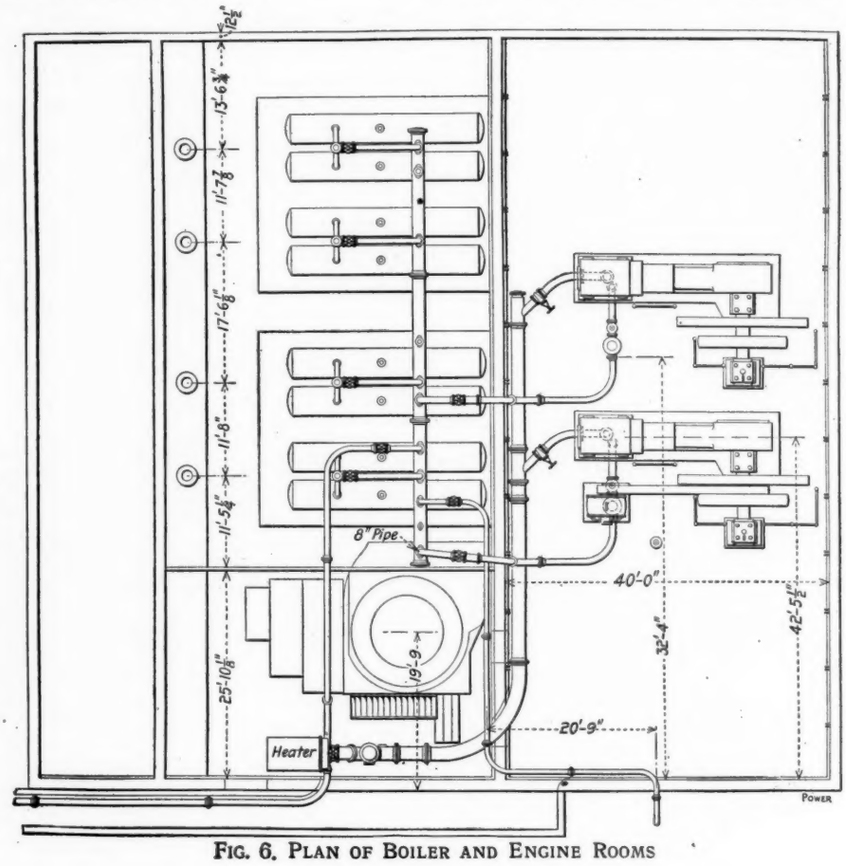


FIG. 6. PLAN OF BOILER AND ENGINE ROOMS

EQUIPMENT OF POWER PLANT OF HAZARD MFG. CO.

No.	Equipment	Make	Use	Rated Capacity in Kw.	Horsepower	Steam Pressure, Pounds	Revolutions per Minute	Volts	Amperes	Phase	Cycles	Size	Manufacturers
4	Boilers	Water tube	Main steam generator	...	300	100	...	...	...	.	..	.....	Babcock & Wilcox Co.
2	Engines	Rice & Sergeant	Main generator units	250	...	100	120	...	...	..	..	22x36	Providence Engineering Works
2	A.-C. generators	Westinghouse	Main generator units	250	...	...	120	440	328	3	60	.....	Westinghouse Elec. & Mfg. Co.
1	D.-C. generator	Crocker-Wheeler	Auxiliary generator	45	...	...	690	250	180	.	..	.....	Crocker-Wheeler Co.
1	D.-C. generator	Westinghouse	Exciter unit	22½	...	...	450	125	180	.	..	.....	Westinghouse Elec. & Mfg. Co.
1	Induction motor	Westinghouse	Auxilary generator	...	60	...	690	440	...	3	60	.....	Westinghouse Elec. & Mfg. Co.
1	Induction motor	Westinghouse	Coal conveyor motor	...	10	...	...	440	...	3	60	.....	Westinghouse Elec. & Mfg. Co.
1	Switchboard	Marble	Mch. and line control	...	...	...	...	...	...	.	..	.....	Westinghouse Elec. & Mfg. Co.
1	Fan	Sturtevant	Forced draft	...	...	...	...	...	...	.	..	5′ wide 10′ dia.	B. F. Sturtevant Blower Co.
1	Damper	Spencer	Damp. and fan control	...	...	...	...	...	...	.	..	.....	Thompson, Richards & Co.
1	Chimney	Custodis	.....	...	...	...	...	...	...	.	..	125′ high	Alphons Custodis Chimney Construction Co.
4	Water columns	Reliance	Safety water column	...	...	...	...	...	...	.	..	.....	The Reliance Gauge Column Co.
4	Regulators	Vigilant	Feed water regulators	...	...	...	...	...	...	.	..	.....	The Chaplin-Fulton Mfg. Co.
4	Blowers	Argand	Steam jet blower	...	...	...	...	...	...	.	..	.....	McClave-Brooks Co.
4	Grates	McClave	Furnace shak. grates	...	...	...	...	...	...	.	..	.....	McClave-Brooks Co.
1	Separator	Sweet	Steam separator	...	...	...	...	...	...	.	..	.....	Direct Separator Co.
2	Pumps	Duplex	Boiler feeders	...	...	...	...	...	...	.	..	10x7x 18	Nelson-Snyder Mfg. Co.
2	Pumps	Vacuum	Heating system	...	...	...	...	...	...	.	..	.....	Nelson-Snyder Mfg. Co.
1	Injector	Hancock	Boiler feeder	...	...	...	...	...	...	.	..	.....	Hancock Inspirator Co.
4	Regulators	Mason	Pump regulators	...	...	...	...	...	...	.	..	.....	Mason Regulator Co.
1	Open heater	Cochrane	Feed water heater	...	1800	...	...	...	...	.	..	.....	Harrison Safety Boiler Works
1	Heating system	Webster	Factory heating	...	...	...	...	...	...	.	..	.....	Warren Webster & Co.
2	Lubricators	Richardson	Force feed	...	...	...	...	...	...	.	..	.....	Richardson Phenix Co.
1	Filter	White Star	Oil filter	...	...	...	...	...	...	.	..	.....	Pittsburg Valve, Foundry & Construction Co.
1	Conveyor	McCaslin	Coal and ash	...	...	...	...	...	...	.	..	.....	Meade Morrison Mfg. Co.
	Piping	Extra heavy	Steam and water	...	...	...	...	...	...	.	..	.....	W. K. Mitchell
	Fittings	Crane	Pipe lines	...	...	...	...	...	...	.	..	.....	Crane Co.
	Valves, large	Chapman	Steam mains	...	...	...	...	...	...	.	..	.....	Chapman Valve Mfg. Co
	Valves, small	Hancock	Steam and water	...	...	...	...	...	...	.	..	.....	Hancock Inspirator Co.

Forces of Expansion and Contraction

By Edward Ingham

Showing force exerted by freezing water within a closed vessel, also that due to the expansion and contraction of a boiler shell when subjected to a considerable change in temperature.

How these factors are provided for in design.

Readers of Tyndall's "Heat: a Mode of Motion," will remember how vividly he pictures the practically irresistible forces which are set up when the atoms which go to make up the material universe are exposed to the action of heat or cold. For example, a sphere of cast iron, only 2 or 3 inches in diameter, with walls as much as ½ inch thick, when filled with water and hermetically sealed, and then placed in a freezing mixture, is violently ruptured in a short time by the all-powerful atomic forces brought into play when the water expands during the process of freezing.

When the iron vessel is placed in the cooling mixture, the water, as it first begins to cool, contracts in bulk. The contraction continues until the point of maximum density, 39 degrees Fahrenheit, or 4 degrees Centigrade, is reached, after which the water commences to expand, and later changes from the liquid to the solid form.

At this point, a small vacuous space exists within the sphere, due, of course, to the contraction of the liquid, and as the expansion and the change from the liquid to the solid form proceed, this vacuous space gradually becomes filled. To accomplish the change, however, more room is required, and this the rigid iron refuses to grant. But its rigidity is powerless in the presence of the atomic forces of expansion, and the iron shell is violently ruptured.

A very simple calculation of the pent-up steam pressure which would be required to burst this iron vessel will give some idea of the tremendous force which has been exercised by the molecules of an ounce or two of water in merely changing its state. In fact, the pressure required would be well over 10,000 pounds per square inch.

The writer recalls an instance where a steam boiler over 7 feet in diameter had been filled over night with water for a hydraulic test on the following morning. The boiler was situated in the yard of the boiler works, and during the night a severe frost set in. As a result, when the boilermakers came to apply the water pressure the following morning, they discovered that the water in the boiler had been converted into a solid core of ice, and a gaping rent in the side of the boiler showed that the shell had been burst along the whole length of one of the longitudinal seams.

The expansion of metals when subjected to the continued action of heat, as in the case of the expansion of water when subjected to cold, is practically irresistible. Thus the rays of the sun, acting down upon railway rails, cause the latter to expand, and unless space is provided at the joints, to permit expansion taking place, the rails will bend and curve and practically wriggle like snakes, as their temperature is increased.

Necessity for Provision against Expansion

Again, in the case of steam pipes, unless provision be made for taking up the elongation which is certain to occur when steam is turned into them, the forces of expansion are such that the pipes, if made of cast iron, will often snap. Also in structural-steel work one of the most important points to be considered by the engineer is suitable provision against these expansive forces.

Although, as stated in the foregoing remarks, the interatomic forces set up in the molecules of iron and steel are well nigh irresistible, yet it is not only possible to make suitable provision against these forces in the design of structures, but it is also possible to put them to practical use. Furthermore, sufficient knowledge has been obtained from investigation and experiment to permit calculations being made to ascertain the limits within which these forces may be usefully controlled. From experiments it is known with great accuracy how much a bar of iron or steel or other metal will expand when heated through a certain number of degrees. The force necessary to elongate such a bar through any given distance is also known within certain limits. Hence, knowing the range of temperature through which a bar is heated, or cooled, it is possible to calculate the stress which is set up in the bar when its free expansion or contraction is prevented.

Considering, for example, the case of a steam boiler 30 feet long whose temperature is raised from, say, 50 degrees, that of the cold water with which it is fed, to 350 degrees, that of the steam which it generates, corresponding to the pressure of, say, 120 pounds. Then the range of temperature through which the metal will be heated is 300 degrees. Taking the coefficient of expansion of mild steel as 0.0000067, the boiler will expand

$$30 \times 12 \times 0.0000067 \times 300 = 0.724 \text{ inch}$$

in having steam raised from cold water, and it will contract in cooling down again to the same extent. The modulus of elasticity of mild steel is about 30,000,000 pounds per square inch. Therefore the stress which will be set up in the boiler plates if these contract 0.724 inch by sudden cooling will be

$$\frac{0.724 \times 30{,}000{,}000}{30 \times 12} = 604{,}000$$

pounds per square inch, a force sufficient to rupture the metal of which the plates are made. This calculation, of course, assumes the boiler to be a rigid structure, which, however, it is not.

Enormous Stresses from Sudden Cooling

Some idea may thus be obtained of the severe stresses which are set up in steam boilers when cold water is run over the hot plates for the purpose of quickly cooling them for cleaning or inspection purposes. Where this objectionable method of cooling down is adopted, it cannot be wondered at if the seams begin to leak and give trouble, or even if a fracture of the plates results. No intelligent fireman having any idea of the enormous stresses produced by sudden cooling, would cool his boilers by playing cold water over the plates while the surrounding brickwork and other parts are hot.

The importance of providing against expansive forces is well seen in the case of steam pipes, particularly where superheated steam is used. The amount of expansion which takes place in a 100-foot length of steam piping when steam is turned on is usually about 2½ or 3 inches for ordinary steam pressures. With high pressures and superheated steam, it is considerably more than this. It will thus be obvious that in designing steam pipes, considerable expansive movements are to be provided for. Numerous devices are employed for this purpose, such as gland expansion joints, mild- or wrought-steel spring bends, copper expansion pieces, etc., and these, when properly designed and fitted, will be found effective in taking up the expansion which occurs.

An incident which might have had serious results occurred some years ago in connection with two boilers which were coupled together. An expansion gland joint was placed on the steam-pipe range between the two boilers, but owing to the fact that the joint was not provided with guard bolts, there was nothing to prevent the free end of the pipe from being drawn out of the gland should the expansion be sufficient. This actually took place, and as the end of the pipe drew out, one of the boilers, which was

empty at the time and was being examined, was gradually turned on its setting through a small distance, much to the astonishment of the inspector.

Liability of Fracture

In the case of steam engines, considerable expansion takes place under steam, especially with tandem engines. If the cylinders be rigidly bolted to the frame or beds so that expansion cannot freely take place, fracture of the cylinder feet or other parts is liable to result, and many breakdowns have occurred in this way. A simple method of avoiding this danger is to screw up the nuts of the cylinder-feet bolts against a ferrule, so that the feet may be allowed to move with the expansion but at the same time cannot be lifted from their seats.

Again, steam boilers must be carefully designed so as to accommodate the expansion which takes place under ordinary working conditions. A large Lancashire boiler 30 feet long will expand ¾ inch in having steam raised from cold water. This expansion frequently makes it difficult to prevent leakage of cold air into the flues; the movement of the boiler forces back the brickwork of the downtakes and a space is thus liable to be left between the back end plate and the brickwork through which cold air rushes and impairs the draft. The difficulty may be overcome by making the covers of such a form that they are capable of moving with the boiler as the latter expands or contracts.

Elasticity to End Plates

The furnace and flue tubes of a Lancashire boiler, being in direct contact with the furnace and hot gases, expand more than the shell. This throws a strain upon the end plates, which frequently leads to grooving at the place where the tubes are attached to the end plates. To avoid such grooving, the boiler must be so designed that these expansive movements are properly provided for, and the tendency to straining is thus reduced to a minimum. This is done by giving a certain amount of elasticity to the end plates, so that they are able to accommodate the expansion of the furnace and flue tubes. Hence, the end plates of modern boilers are made as thin and as light as is consistent with safety. Furthermore, no end gusset stays are carried down nearer than about 10 or 11 inches from the circle of rivets in the furnace angle irons or flanges, so as to leave a certain amount of breathing space. In this way, the ends of the boiler are made sufficiently elastic and flexible to take up the motion of the internal tubes as these lengthen and shorten due to changes in pressure and temperature within the boiler.

In building a steam-engine crank shaft, the crank is bored to a diameter slightly less than the boss of the shaft on which it is to be placed. It is then heated in a fire, and expands the diameter of the bored hole, increasing sufficiently to permit the crank being placed on the shaft. After placing on the shaft, the crank is allowed to cool, and as cooling goes on, contraction takes place and the crank grips the shaft so tightly that there is little possibility of its being moved afterward even under the heavy strains to which it is exposed during working. Flywheels, engine beds, etc., are frequently fastened together by hoops put on while hot, which, on cooling, make a very secure fastening.

Utility of Contraction

Again, the contractile force of cooling metals has been utilized by engineers for straightening the bulged or leaning walls of buildings. Long bolts with large washers and nuts are placed between the walls, the nuts and washers being screwed up until they bear against the walls. The bolts are then heated and consequently expand, and the nuts, which, of course, become slack through the lengthening of the bolts, are screwed up again. On leaving the bolts to cool, contraction results and the walls are thus gradually pulled to the required position.

Many other such instances might be cited, but sufficient has been said to show that engineers are not only able, by careful design, to provide against the forces of expansion and contraction, but they can, under certain circumstances, put them to actual practical use as pointed out.

Water Supply from Underflow of River

By C. W. Wiley

The accompanying photograph shows the discharge of over 2100 gal. per minute from a well only 44 ft. deep and 2 ft. in diameter. The discharge pipe is 8¼ in. in diameter, and the well could have easily supplied 50 per cent. more water than it did on the test had it not been for the limiting capacity of the pump and the small traction engine driving it. The head of water in the well was lowered only 15 ft. in supplying this large quantity of water.

The well is one of two supplying city water for Arkansas City, Kan., the supply being taken from the underflow of the Arkansas River.

The picture shows the results which may be attained by proper methods applied to well-work and furnishes an evidence that there is an almost inexhaustible source of clean, cool water in all river valleys having an underflow through sand beds. A similar well and pump have just been put in at Evansville, Ind., for the Evansville Public Service Co., to secure condensing water for its turbines. This well is 110 ft. deep and furnishes an abundant supply of water, the temperature of which is 56 deg.

The underflow of the Ohio River is also very favorable for furnishing large quantities of cool water. Many cities in the Ohio Valley are using the river water and many power plants in such places are either running noncondensing or on low vacuums, due to warm condensing water, not realizing that an unlimited supply has been furnished below them.

Pump Working at Full Capacity

Confessions of an Engineer

By R. O. Warren

Manager Wood believes that it is more economical to sell exhaust steam than it is to run the engines condensing.

Money is made by carrying out the idea and the engineer again sees where he could have made good.

It is said that one learns as he grows older. This may be true in some instances, but it did not seem to have been so in my case. The instance of the smoke-recording device did serve to make me look about the plant for something more that could be improved upon, but as nothing came to my immediate attention I soon lapsed back into normal conditions.

Another Jolt

Matters went on smoothly for a time until Wood gave me another jolt. He strolled into the engine room one afternoon and found me working on one of the tandem-compound engines. After the usual greeting he said, "How much steam goes to waste during a year, do you suppose?"

"Just what do you mean?" I inquired, with some surprise, for I had never given the matter a thought.

"About how much money are we throwing away that could be saved?" answered Wood.

Wood had me stumped for I had never made any attempt at keeping a record of what became of the steam after it was made. It was doubtful if I could have told how great the steam losses were, anyway. I certainly did not know how much water was used; I just pumped the water out of the pond and shoveled coal into the furnace.

Although I made a report of the amount of coal consumed each day and knew how many tons I used in a year, there were a good many sources for steam waste, now that my attention had been called to the fact, that could possibly have been stopped.

Continuing, Wood said: "Our conditions are the same as many other establishments. We operate the main engines during the day and a small engine during the night, so that there is considerable loss of exhaust steam, or would be if we were not running condensing during the 24 hours. The question is, is it cheaper to run condensing than it would be to run noncondensing and use our exhaust steam?"

"I suppose we could use exhaust steam for heating the shop," I replied, "as you know at present we run condensing and the live steam is used for heating purposes. If there is no other use for the exhaust steam, I do not see how you are going to utilize all of it."

Creating a Demand for Exhaust Steam

"What is the matter with creating a demand for the exhaust steam? Now there is the Knox shoe factory, which is motor driven from the central station; it could use exhaust steam for heating purposes if the price could be made attractive. As it now is, a boiler is kept under steam during the winter for heating and a small boiler for supplying steam for manufacturing purposes during the warmer months. Why couldn't we heat their shop for them?"

"Well, I suppose we could. About 70 or 80 per cent. of the steam taken from the boilers would go to the exhaust pipe, were we running noncondensing; well, perhaps a little less, taking the heater into consideration. Take this 500-hp. compound engine; it is using somewhere in the neighborhood of 15 lb. of steam per horsepower per hour, when cutting off at ⅓ stroke, with 100 lb. boiler pressure on the high-pressure cylinder. That would make—let me see—500 × 15 × 0.7 = 5250 lb. of steam that would go up the exhaust pipe each hour, and 5250 × 10 = 52,500 lb. of steam which would escape through the exhaust pipe in 10 hours. Of course, the night loss would be somewhat less."

Continuing the calculation, I said: "Take the small 100-hp. simple engine which we run at night and the steam consumption would be about 26 lb. per horsepower per hour, or 100 × 26 × 14 = 36,400 lb. of steam for the 14 hours' run. That makes a total of 52,500 + 36,400 = 88,900 lb. per each 24 hours' run."

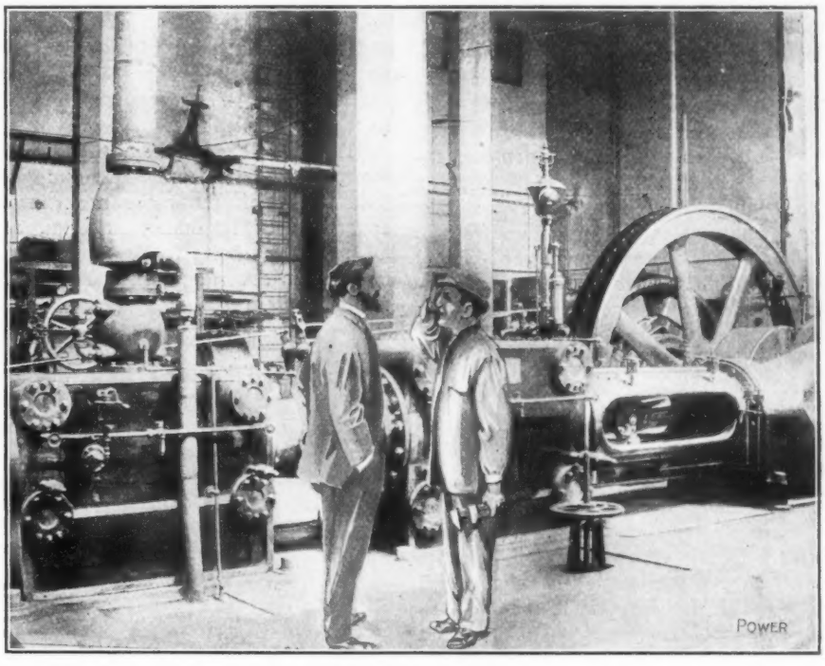
"Well, that would be worth saving, wouldn't it?" asked Wood.

Reaching Out for Consumers

"Why, yes," I answered. "Of course it would, but how are you going to do it? The Knox Shoe Co. does not want to use all of the exhaust steam we make, or could make, even if you could get it to shut down its boilers and discharge the two firemen."

"There is the Linden Shoddy Co. within a stone's throw of us. It runs by water power and uses steam in the process of manufacture. A boiler has to be kept in service for that purpose and a day and night fireman are each paid $1.70 per day besides the item of fuel, which amounts to about 1½ tons a day. This costs $6.15, and with the firemen's wages would amount to a total of $9.55 per day, the cost of running the steam end of the plant. I know this company could save money if it used our exhaust steam.

"Then there is the Brooks Machine Shop. Its power plant is about on its last legs and half of the shop is motor operated from our electric plant at the



Wood Found Me Working on One of the Engines and Wanted to Know How Much Steam Was Being Wasted

present. It would not cost much to run our exhaust-steam main to the Brooks plant and heat the place with the steam we are using in furnishing it with electrical energy."

"By George, I don't know but you are right," I exclaimed. "It is funny I hadn't thought of this myself. Why, it was way back in 1872 that the first system of the kind was installed up in Lockport, N. Y., and since then the idea has been so well advanced that now it is a regular business with some companies to make and sell steam for heating purposes alone, while others, such as electric-light and power plants, make a business of selling the exhaust steam to nearby office buildings, etc. The fact is that the business has been so advanced that one can purchase insulated piping, expansion joints, heaters, etc., without having them made especially for the purpose. All one has to do is to order the goods—and pay for them," I added, as an afterthought.

"Yes, I suppose these supplies, etc., have been made standard. Now, my way of figuring it is that there are from seven to eight months of the year when these three companies will want steam for heating purposes and I believe that there is a neat little business that can be obtained if we want it, and go about it in the right way."

"Of course, running condensing reduces the back pressure on our engines and running noncondensing and selling the exhaust steam would put from 2 to 10 lb. back pressure on the engine, which will necessitate a greater coal consumption for the same amount of power utilized in driving the factory."

"Ten pounds is pretty high back pressure," said I, looking wise.

Where Power Cost Practically Nothing

"Not so very much," rejoined Wood. "I see where they are running steam turbines in textile mills as reducing valves, taking steam from the second stage for the purpose of heating water, etc., and it has proven to be so economical that the power to operate the mill costs practically nothing, outside of the interest of the investment tied up in the turbines.

"My idea is to shut the condensers down during the cold months and sell the exhaust steam to these three companies. We have more engine capacity than we require and I do not believe that the slight back pressure will amount to very much when compared to the revenue that can be obtained from the sale of the exhaust steam. Another thing, during semi-cold weather, when there would be more exhaust steam than could be used, some of the engines could be run condensing and the exhaust-steam load kept at a point just sufficient to supply the demand.

"Of course there would have to be a live-steam connection from the boiler to the heating main, so that a steam supply could be had in case all of the engines were shut down at the same time. A reducing valve would have to be used to keep the steam pressure between the 2- and 10-lb. pressures. I guess that would about fix things."

"Not so fast!" I exclaimed, for as Wood's idea became evident I began to see where the details would fit in. "There will have to be a bypass around to the reducing valves, a back-pressure valve would be required in the atmospheric exhaust pipe and it will be necessary to have an oil and water separator in the underground pipe leading to the heating main, besides the necessary gages and recording devices. If you are going into this thing there is no use half doing it."

"Then there is the insulating of the steam pipe. There will be no use of running a lot of piping to these companies and then find that there is no steam to sell because it has all been condensed on its way to them."

Best Way to Lay the Pipes

"Huh! I hadn't thought of that. What do you consider the best method of laying the pipes? Of course, they will have to be insulated."

"There are several ways of putting in the pipes," I replied. "There are conduits in which the pipes are run and covered with insulating material, such as asbestos, hair felt, mineral wool, magnesium covering, cork and other materials."

Insulating the Pipes

"I remember reading some time ago that the best result according to tests were obtained from pipes which were covered with sheet asbestos and inclosed in round, tin-lined, white-pine stave casings, having a shell thickness of from 4 to 5¼ in. The interior diameter was sufficient to allow of an annular dead air space of not less than 1 in. between the tin lining and the asbestos covering. The pipes were held in place by means of guides on rollers."

"Sounds good, but I should suppose that the wood would soon decay from contact with the earth."

"No, you see it is coated with asphaltum and then rolled in sawdust. It is then covered with three-ply, extra-heavy tar paper. This protects the pipe from excessive electrolysis and reduces the heat radiation to a low degree."

"There will have to be extension joints and anchorages to make the system up to date. The more I think of it, the more I believe it will pay."

Where the Profits Came In

"Now, the Knox company has, according to its engineer, about 4000 sq.ft. of heating surface in its plant. We could afford to supply steam for about 0.0011c. per square foot per day of 24 hours, or, $0.0011 \times 4000 = \$4.40$ per day. At that rate, the company would make a profit, and without any trouble, of $5.15 each day. Worth saving, I should say. Of course the proper way would be to put in a suitable meter and then you would know exactly where you stand and how much steam each firm is using."

The upshot of the matter was that contracts were made, the piping and other necessary apparatus were purchased, and at the end of the next year Wood found that a neat sum had been collected from the sale of exhaust steam, so much, in fact, that the system was extended and the revenue increased until the system was fully loaded.

While Wood gave me credit for working out many of the details, the big thought was his, while it might have been mine just as well, and that is the way it goes with most of us.

Transmitting Power by Ropes

By Everard Brown

The amount of power that can be transmitted by a rope drive is limited, to a certain extent, only by the size of the installation. There are numerous drives of 4000 hp. that are running satisfactorily, while systems of from 1000 to 2000 hp. are quite common. For transmissions exceeding 4000 hp., however, the rope drive is not so generally used. A single rope, 2 in. in diameter and running at a speed of from 4000 to 4500 ft. per minute, will easily transmit 50 horsepower.

The speed and working tension are the two most important factors that determine the amount of power that can be transmitted by a given sized drive. The best practice as to speeds seems to be between 4000 and 5000 ft. per minute, although some as low as 2000 ft. have been used. It is hardly advisable, however, to exceed 5000 ft., for as the speed increases the available tension for transmission is reduced; in fact, at speeds over 4800 ft. per minute the centrifugal force increases faster than the power, due to the increased velocity. Furthermore, the wear on the rope is much greater at very high speeds because of the more frequent bending over the sheaves, thus causing internal wear by the rubbing of the fibers on each other. There is also a greater amount of slipping and wedging in the grooves of the pulleys. It is usually assumed that both of these causes of wear are directly proportional to the speed.

In calculating the power that can be transmitted by a certain sized rope it is common practice to assume that 1 lb. of tension on the slack side is equivalent to 2 lb. on the driving side and that the maximum strain advisable to put on

is about 200 times the square of the diameter of the rope. The centrifugal force must, of course, be deducted from the force available. This centrifugal force is found by multiplying the weight of the rope in pounds per foot by the square of the velocity in feet per second and then dividing this product by the force of gravity, or 32.16. Upon this is based the following formula:

$$A = \left(200d^2 - \frac{WV^2}{g}\right) \times \frac{2v}{3}$$

in which

A = Power in foot-pounds per minute, available for actual work;
d = Diameter of the rope in inches;
W = Weight of rope in pounds per foot;
V = Velocity of rope in feet per second;
v = Velocity of rope in feet per minute;
g = 32.16.

If the result is desired in horsepower, divide by 33,000.

Assuming, as an illustration, a 2-in. rope, which weighs about 1.4 lb. per foot, running at a speed of 4200 ft. per minute, the power that could be transmitted would be

$$\left[(200 \times 4) - \frac{1.4 \times 4900}{32.16}\right] \times \left(\frac{2 \times 4200}{3}\right)$$

$$= 1{,}639{,}750 \textit{ foot-pounds}$$

or

$$\frac{1{,}639{,}750}{33{,}000} = 49.69 \textit{ hp.}$$

In order to obtain the maximum arc of contact, the lower should always be the tight or driving side and the rope should be allowed to sag quite freely so that it will hang between the pulleys in catenary curves approximating parabolas. The distance between the sheaves may range anywhere from 20 to 150 ft., but for vertical drives they should be at least far enough apart horizontally to get proper adhesion.

Experience has demonstrated that the grooves in the sheaves incline toward each other at an angle of 45 deg., so that the rope cannot touch the bottom. The successful running of a rope drive also depends largely upon the sizes of the pulleys, which should never be less in diameter than 30 to 40 times the diameter of the rope.

The Continuous System

In this system, sometimes called the "American" system, the rope is continuous, being wound spirally around the driving and driven pulleys as many times as needed to transmit the required horsepower; then the last wrap is carried over a tension pulley and back to the first groove of one of the main pulleys. The tension pulley is usually mounted on a carriage so as to preserve a certain tension on the rope and to be free to take up any stretch. The driving and driven pulleys should be so placed that their grooves will be out of line one-half their pitch and, as there is no great tendency for the ropes to sway, the grooves may be made quite shallow; this will avoid severe chafing of the rope due to this side lead. It is not advisable to have them so shallow, however, that the rope will extend beyond the flanges.

In vertical drives, as well as those where the sheaves are close together, the continuous system has its advantages because under such conditions it is necessary to keep the rope relatively taut, which can easily be done by means of the tension pulley. Another advantage is that the ropes must necessarily revolve or turn in the grooves, a condition that seems to be desired as it results in even and uniform wear of the rope by preventing it from becoming wedge-shaped and thus shorten its life.

For the larger drives, however, particularly horizontal ones, where the distance between the pulleys is 40 ft. or more, this method of driving is not so generally used, one of the principal reasons for this probably being that it necessitates a very long rope to be carried as a spare and a suspension of operations until a new rope could be put on or the old one repaired should the rope break.

The Multiple System

The multiple, or so called "English," system is much simpler than the continuous system and is therefore more popular. It consists of one or several individual ropes working side by side, which necessitates, of course, many more splices than in the other method, but it has the advantage that, if one of the ropes should break, the load can usually be transmitted by the remaining ropes until closing-down time, when a new one can be put on; hence there need be no interruption or delay in operations.

A peculiar feature of the multiple rope drive is that frequently some of the ropes revolve in the grooves while others do not. There appears to be no explanation for this; it is the consensus of opinion, however, among men experienced with rope drives that the life of the rolling rope is from 15 to 20 per cent. greater than that of the nonrolling rope. This, it is claimed, is due to the nonrolling rope finally becoming wedge-shaped, and that the two sides thus formed by the grooves sustain the largest portion of the external wear. There are several ways of forcing a rope to revolve, one of which is to move it out of line one groove, or more if necessary, and another is to turn the drive slowly and twist the rope vigorously on the tight side as the driver is approached.

Splicing

No doubt most of the troubles encountered in rope drives are caused by bad splicing; therefore, too much attention cannot be paid to this point. It is absolutely essential for success with this type of power transmission that the diameter of the splice be the same as that of the original rope and that it be smooth and free from lumps. The original lay of the strands must be disturbed as little as possible and where the several strands are rejoined each fastening should be made in such a manner as to prevent its wearing away and the rope unstranding.

The number of strands to be used in a rope is a somewhat contested point. For small drives having rope of small diameter and subject to much bending, the three-strand rope is considered good; while for large drives the four- and six-strand ropes are preferred as they are more nearly circular and of greater cross-section, thus securing larger surface of contact in the grooves. The rope of four strands, however, has again a slight preference over that of six as it is not so difficult to splice.

Manila rope, especially for mill work, where properly proportioned sheaves can be used, no doubt gives better satisfaction than cotton rope. It is more durable, has a greater tensile strength and less stretch than the other. It is also more easily spliced and is considerably cheaper.

Manila Rope

The following information relative to the source of manila rope might be of interest:

It is made from the fiber of the abaca plant, which grows only in the Philippine Islands, and the trunk of which somewhat resembles that of the banana tree. This trunk is closely covered by long leaves from which the fiber is procured in lengths ranging from 5 to 10 ft., and sometimes as long as 18 ft. The tensile strength of the fiber is remarkable only when subjected to a longitudinal strain as, transversely, owing to its cellular formation, it is comparatively weak. It is, therefore, quite essential in manufacturing the rope to exercise the greatest care to secure the right amount of twist, etc., in both yarns and fibers so as to avoid any crosswise strains, and also to prevent as much as possible the wear and tear resulting from the rubbing of one strand upon the other while passing over the pulleys.

A Montreal syndicate, it is reported, has prepared plans for a million-horsepower hydro-electric development near Montreal. It is proposed to divert the whole course of the St. Lawrence River at Coteau and Cedar Rapids. The cost of the dam will be $25,000,000, and the syndicate's capitalization is said to be $100,000,000. To pay dividends on this enormous sum will require the development of nearly one-half million horsepower.

Application of the Arithmetical Mean

By Julian C. Smallwood*

The arithmetical mean as applied to engineering observations and some of the errors resulting from its indiscriminate use.

*Associate professor of experimental engineering, Syracuse University.

There are two distinct conceptions of the arithmetical mean. For example, when referring to the mean effective pressure of a steam engine, it signifies a single quantity that represents or replaces a series of varying values of the steam pressure. The process involved is theoretically without error, for if a rectangular indicator diagram be constructed having the mean hight of the actual one, the area obtained from it will equal the area of the actual diagram. What is done is to replace for a varying quantity a constant one which produces exactly the same result. The process has, of course, unlimited applications.

On the other hand, the problem may deal with a number of discordant results obtained from various measurements of a single constant quantity. For example, under exactly the same conditions of load and running, and using the same care in making measurements, the water rate of a steam engine may be variously determined. One is forced to the conclusion, then, that some accidental errors in measuring have occurred and these account for the variation of the results. There is, however, no reason for believing that any one of the results is more doubtful than the rest. Under these circumstances, the most natural course is to take the mean of the determinations; that is, to divide the sum of the results by the number of determinations, and to consider this result as the best one obtainable from the data. This is not only the most natural procedure; it is obviously correct. But if asked why it is correct, it will be difficult to obtain a satisfactory answer. To prove it unaided will probably be impossible.

Substantial causes for doubt of the arithmetical mean may easily be found. Suppose calculations have been made for the same quantity, using a slide rule from which could be read three significant figures, these determinations and their mean being as follows:

```
3.96
3.99
4.00
3.98
-----
4)15.93
  3.9825
```

That is, a result has been obtained having two more decimal places than any of the single measurements. But, as stated, the limit of accuracy of the instrument is the second decimal place; hence, the question arises as to whether any confidence may be placed in the 0.0025 of the result. The question cannot be answered offhand. It may be answered, however, by first calculating the probable error of the mean.

Consider a case in which the arithmetical mean is wrongly applied. Referring to Fig. 1, suppose that the points A and B have been measured from X and that, as a check, the distance between A and B has been measured. The determinations are 20 feet, 22 feet and 3 feet, as shown, and therefore the results do not agree. There is, however, no reason for doubting any one of the measurements more than the rest. Therefore, it is desirable to modify them so that the most accurate result will ensue. It seems obvious that the arithmetical mean may be used, and one will naturally take as the determinations of the position of A,

$$(20 + 22 - 3) \div 2 = 19.5 \text{ feet}$$

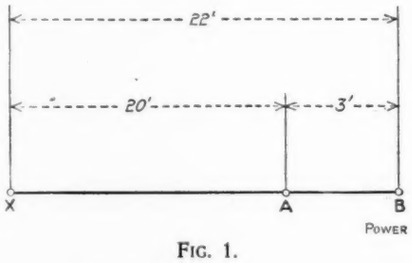


FIG. 1.

as the mean. Similarly one might take for the two locations of B, 22 feet and 20 feet plus 3 feet, in which case the mean is 22.5 feet. But by this method of adjusting the values there is no correction of the distance AB, which is still 3 feet. One might adjust the data in the same way so that there will be no error in the measurement of XA or of XB. Which set of values, then, should be selected as approximately correct?

There is only one way of adjusting such data and that is by the method of least squares. The location of A obtained by first measuring B is indirect and to such measurements the arithmetical mean does not apply. The lesson to be learned from this example is that when adjusting data to get the most accurate result the arithmetical mean applies only to direct determinations upon a single quantity. This use, however, must not be confounded with the other purpose of the mean, previously considered.

It might be well here to point out a mistake that is often made in calculating the arithmetical mean. Sometimes it is necessary to obtain the mean of a large number of quantities which have been arranged in groups, already averaged, such as the following:

```
51        52
52        53
53        54
54        55
55        56
          57
5)265     ----
  53    6)327
        -----
        54.5
```

The mistake referred to consists in getting the total mean, thus

$$(53 + 54.5) \div 2 = 53.75$$

Clearly this is incorrect, because

$$(265 + 327) \div 11 = 53.82$$

This mistake is caused by averaging the averages of groups having unequal numbers of the quantities averaged. If the groups contain the same number of quantities the process is a correct short cut.

Another very common mistake made in averaging is to include in the quantities averaged one or more of doubtful value. Consider, for example, four tensile tests upon the same steel resulting as follows:

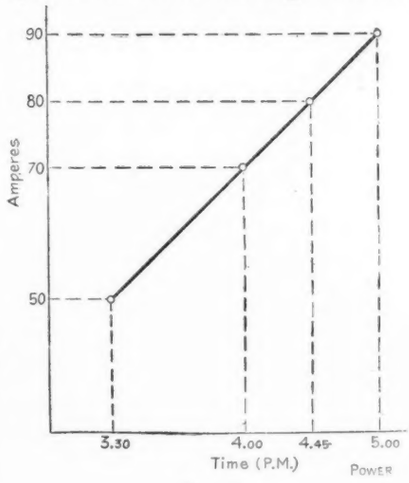


FIG. 2.

```
60,000 pounds
61,000 pounds
62,000 pounds
33,000 pounds
-------------
Mean value 54,000 pounds
```

This result is unfair to the material. It would be a natural inference that because the last specimen failed at so much less load than the other three, it was defective. If this result is omitted the mean will be 61,000 pounds. In general, then, one must examine and compare results that are to be adjusted and cast out or modify those whose peculiarities can be accounted for by circumstances not applying to all of them. If this is not done the arithmetical mean may have no significance whatever. As a rule, for adjusting determinations it

must be applied only to those quantities which are equally reliable and subject to the same accidental causes of error.

Another improper calculation of the arithmetical mean is due to lack of consideration of the element of time. Suppose readings of an ammeter registering

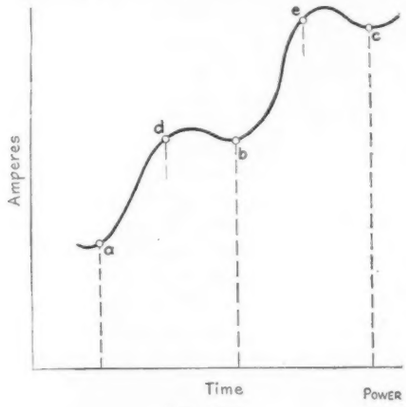


FIG. 3.

a uniformly increasing current are taken. Fig. 2 represents the actual variation of the current, amperes being plotted against time, such as would be obtained from a recording device. The actual mean amperage is then the mean hight of the curve, or 70 amperes. If no recording device is used and readings are taken by an observer at irregular intervals of time, such as are indicated, the resulting mean would be

$$290 \div 4 = 72.5$$

It is evident, therefore, that such observations should be made at uniform intervals of time.

that the more determinations that are made of a desired quantity, the more precise is the mean resulting from them.

There are many cases where the rule of the mean, as used to obtain a single quantity representing a varying one, is theoretically wrongly applied, yet the error introduced into the result is negligible for practical purposes. In the use of the throttling calorimeter, for example, the quantities from the steam tables corresponding to each set of thermometer readings should be substituted in the heat equation and the resulting values of the quality averaged. The common method of averaging the observations and applying the heat equation only once for all of them yields a somewhat erroneous result. Generally, in such a case, the smaller the variations in the readings, the less the error involved in the use of the mean.

What has been so far adduced goes to show that certain uses of the arithmetical mean lead to wrong results. There are also other cases wherein it is doubtful how it should be obtained. In this connection, consider a series of determinations made for the quantity of water discharged as measured by a venturi meter. This instrument gages the flow of water through a pipe by the difference in level of a water or mercury column. The formula is of the form

$$Q = K\sqrt{h}$$

Q being the quantity in cubic feet per second; K, a constant depending upon the instrument, and h the reading from the U-tube employed. This and similar forms of equation are used in a vast number of engineering calculations. With a number of readings of h and wishing to obtain a mean value of Q, one may get two different results, depending upon whether one first averages all the values of h and substitutes their mean in the equation or substitutes each value of h in the equation and then calculate the mean of the resulting values of Q. The difference is that between taking the square root of the mean of a number of quantities or the mean of the square roots of the quantities. To determine which is the better procedure it is necessary to determine the conditions of operation. First, assume that the rate of flow is absolutely constant. The variation is then due to errors in the records, either through the imperfect sight of the observer or through accidents influencing the manometer external to the rate of flow. Clearly, then, the readings should be averaged, because by doing so a more precise result is obtained to represent the quantity in which there is supposed to be error.

If, however, it is known that a high degree of precision has been maintained in the observations, and that the rate of flow fluctuated, the rate at the time of each reading may then be considered to be exactly the quantity calculated from that reading. In this case, the rates should be averaged, and not the heads.

Enough has now been presented to convince the reader that the rule of the arithmetical mean may not be applied without careful consideration and that serious error may follow its indiscriminate use.

Locomotive Came to Grief

The extent to which coal mining is carried on long ago necessitated the abandonment of mules for transporting purposes and the adoption of narrow-gage locomotives in their stead. In fact, the progressive mine cannot well do without them. Occasionally these little locomotives come to grief and are wrecked as completely as are the larger ones on trunk lines.

The illustration, Fig. 1, shows a type of these locomotives which can be found in almost any mining community. Fig. 2 shows what is left of an engine which, due to carelessness or confusion on the part of the engineer, ran off the end of a culm-pile track, wrecking itself as shown, and demolishing with other pipes a 14-in. steam line.

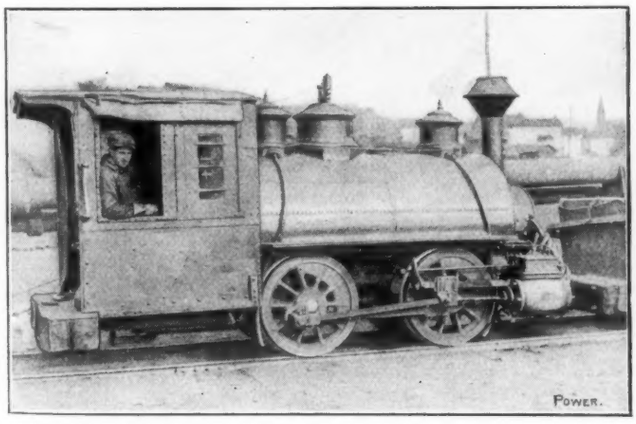


FIG. 1. TYPICAL MINE LOCOMOTIVE

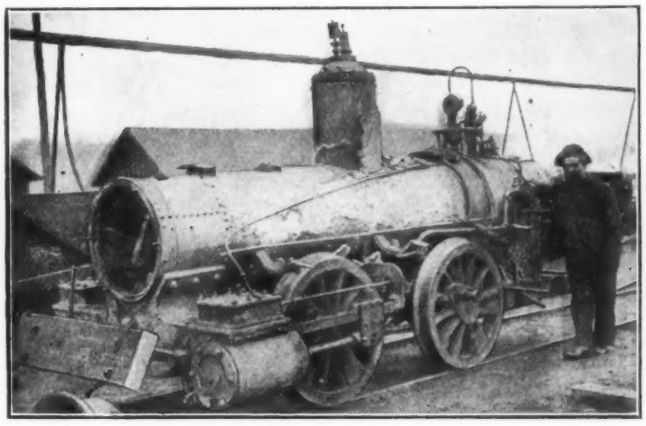


FIG. 2. AFTER AN ACCIDENT

A Proposed Basis for Coal Purchase

By John P. Cosgro

These specifications are compiled on the assumption that the available heat, or what has been called for convenience "commercial effect," in a unit of coal when hand fired either in a gas producer or under a steam boiler is not proportional to the total combustible content, but is practically dependent for its value on the fixed carbon modified by the percentage of ash and moisture.

The United States government for some purposes is buying coal on a B.t.u. basis as determined by coal calorimeter tests, but as this gives the accurate value of coal only when burned under ideal conditions it is not an accurate measure of its commercial value.

This statement is based on the results of tests by eminent authorities and on personal experience, which indicates that the volatile combustible matter in coal burned under even the best commercial conditions is so easily lost by imperfect combustion that the fixed carbon may be taken as the principal useful element.

It is not true that 1 per cent. of moisture is as detrimental as 1 per cent. of ash in the coal under all circumstances, nor that a reduction of one unit of either is equivalent to the addition of 1 per cent. of fixed carbon, as these are all variable factors; but ordinary practical operation gives results closely approximating these values and a simple working formula for comparing the commercial value of different coals is obtained by such an assumption.

If the provisions of the specifications are enforced, they will insure that the coal furnished will be of a uniform quality, or, failing this, proper adjustment will be made. They will also encourage the dealer to maintain or enhance the quality of the shipments by offering him a bonus for an increased percentage of fixed carbon or a decreased percentage of ash and moisture.

While the gain to the purchaser will be in a slightly increasing ratio to the amount of bonus paid, the dealer will not be the loser thereby. In other words, the dealer gets paid for exactly what he furnishes, while the buyer pays only for what he gets but gains by having less waste matter in the coal.

It is not expected that the proposed system will meet with the unqualified approval of the coal producer at the start as it limits him rather closely at a point where he has hitherto been free to ship an inferior grade with no fear of being penalized.

To coal companies which have confidence in the superiority of their product and which desire to trade on a strictly business basis, this method offers many advantages, as the price they receive per ton is controlled by the grade of coal supplied, limited, of course, by the provisions of the specifications, and it is believed that once the arrangement is made clear to any coal company looking for business, no difficulty will be experienced in getting it into line. The method of putting this system into operation would be to have a coal company submit either a standard sample or a statement of the fixed carbon, ash, moisture and sulphur content of the coal they propose to furnish under the terms of the specifications which would be made a part of the buying agreement together with prices, tonnage and shipping facilities. In some cases where the coal dealers have a monopoly it will be necessary to use considerable care in getting the system into operation, but a large consumer should have no great difficulty in effecting an agreement along the lines laid down. Where competition is keen the provisions of the specifications should be rigidly enforced, as the conditions are entirely equitable.

It may be advisable to send a representative to visit any accessible coal fields for the purpose of determining the best economic grade to be adopted as a standard, get an idea of the facilities of the company for furnishing a continuous supply, and possibly to establish working relations on a friendly basis.

The matter of sampling will, of course, require some threshing out before a working arrangement is agreed upon, but when it is considered that practically all metal mines dispose of their product along similar lines, no serious difficulty need arise.

The expense of making the necessary proximate analyses will be comparatively slight, and the sampling can be supervised by the engineer or some other qualified person.

Proposed Standard Coal Specifications

It is the intention of these specifications to provide for the maintenance, within reasonable limits, of a uniform percentage of fixed carbon, ash, moisture and sulphur in the coal furnished hereunder by (a) establishing a standard percentage in the case of the first three constituents and paying a bonus for an increased percentage of fixed carbon or a decreased percentage of ash or moisture; (b) by penalizing in the same ratio a decreased percentage of fixed carbon or an increased ash or moisture content; (c) by putting a limit on the maximum acceptable percentage of sulphur; (d) by establishing a rejection limit of 10 per cent. above or below standard.

Standard Grade

The standard grade to be taken as a basis for settlement is to be that quality of coal forming the base of the buying agreement and on which the standard price is fixed, the numerical value of which will be the "commercial effect" as defined in the following paragraph.

"Commercial Effect"

It is assumed that ash and moisture are equally detrimental in the fuel and that a reduction of 1 per cent. of either constituent is equivalent to an increase of 1 per cent. of fixed carbon; therefore what will be termed for convenience "commercial effect" in a shipment of coal will be determined by subtracting the sum of the ash and moisture in percentage from the percentage of fixed carbon in the coal. Thus:

Commercial effect = per cent. fixed carbon — (per cent. ash + per cent. moisture)

For instance, assume the buying agreement to be based on a coal of the following composition:

	Per Cent.
Fixed carbon	60
Ash	12
Moisture	5

Then

$$12 + 5 = 17$$

and

$$60 - 17 = 43 \text{ } \textit{commercial effect}$$

which, in this case, is also the unit of standard grade or standard commercial effect, as the buying agreement was predicated on coal of this quality.

Settlement

As the conditions under which this coal is to be used favor a high percentage of fixed carbon and a low ash and moisture content, a *pro rata* settlement will be made on each car lot, providing a bonus or a penalty accordingly as the commercial effect of the shipment compares with the standard commercial effect. Thus assuming the buying agreement to be based on coal of 43 per cent. commercial effect at $5 per ton and that shipments showed the following composition:

	Per Cent.
Fixed carbon	62
Ash	11
Moisture	3

$$\textit{Ash + moisture} = 11 + 3 = 14$$

$$62 - 14 = 48 = \textit{commercial effect}$$

Then the settlement basis equals

$$\frac{48}{43} \times 5 = \$5.58 \textit{ per ton}$$

Again assuming the same standard grade and price, the shipment shows composition as follows:

	Per Cent.
Fixed carbon	58
Ash	14
Moisture	4

$$\textit{Ash + moisture} = 14 + 4 = 18$$

$$58 - 18 = 40 = \textit{commercial effect}$$

Then the settlement basis equals

$$\frac{40}{43} \times 5 = \$4.65 \textit{ per ton}$$

Sampling

Each car of coal shall be sampled separately and an individual settlement made thereon; a sample of approximately 100 lb. per car will be taken during unloading, care being taken to secure pieces representing the average quality of the shipment. This sample will be broken and divided to about 10-lb. pieces which will be reduced to 40 mesh for proximate analysis on the results of which the commercial effect will be calculated by the above method and settlement will be made in accordance therewith.

The process of sampling and analysis shall at all times be open to representatives of the coal dealer and of the buyer, and each party shall receive a sufficient sample for check analysis and a further sample shall be placed in a sealed, stoppered jar for future reference until the settlement is made.

Rejection Limit

The constituents of fixed carbon, ash and moisture shall not vary to exceed 10 per cent. above or below the standard grade in any car lot and a variation in excess of this amount shall be considered just and sufficient cause for the rejection of shipments at the purchaser's option and the coal company shall reimburse the purchaser for freight paid on any shipment rejected under this clause.

An excess of 1.5 per cent. of sulphur will also be considered sufficient cause for rejection of any shipment subject to the same conditions as above.

Proposals

Parties bidding on coal under these specifications are requested to forward to the purchasing agent a proximate analysis of the grades they are prepared to furnish, together with the maximum and minimum tonnage they agree to supply under the terms stated herein, also to describe in detail any suggested departure whatsoever from these specifications, together with their reasons therefor.

Electric Traction in London

An idea of the growth of electric traction in London may be gained from the following account of the work of the London county council. This council was constituted under the local government act of 1888, its administrative area being over 120 sq.m., and one of its most important committees, the highway committee, has supervision over the tramway system.

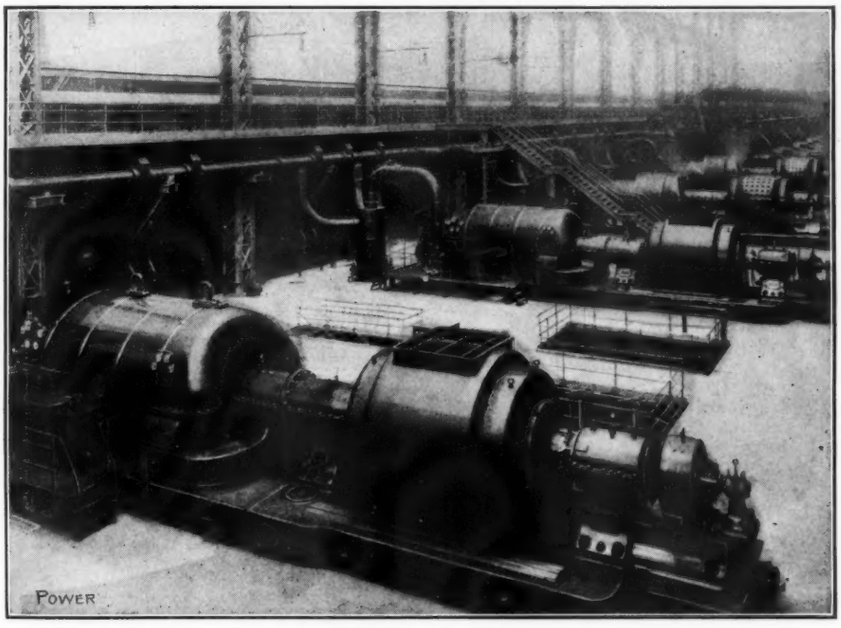
The London County Council Tramways consists of what was formerly a number of independent tramway undertakings operating within the county of London, together with certain new lines subsequently built by the council. Each of these companies owned from 4 to 50 miles of line, but gradually the council has taken over by purchase all the tramway companies within its area. The first transfer took place in 1895 and the last in 1909.

At the end of March, 1910, the system extended over 135½ miles of street, of which 115½ miles were electric lines. The remaining 20 miles were at that time still worked by horse traction, but the latter have now practically all been converted to electricity.

The accompanying table indicates the progress which has been made with the work of electrification. In some years it will be observed that while the amount of electrified lines increased, the length of horse lines also increased. This is accounted for by the acquisition by the council of other tramway undertakings.

	Electric traction in operation	Horse traction	
	Street miles	Street miles	Total Street miles
March 31, 1904	19¼	69⅜	88⅝
March 31, 1905	26⅝	68¾	95⅜
March 31, 1906	30⅜	73⅝	104
March 31, 1907	58⅞	57⅞	116¾
March 31, 1908	68⅝	51¾	120⅜
March 31, 1909	84⅜	54⅛	129½
March 31, 1910	115½	20	135½

The total capital outlay of the London County Council Tramways amounted on Mar. 31, 1911, to about $50,000,000.



Main Turbine and Engine Room of Generating Station

Generating Station

The electric-generating station for the whole tramway system of London is situated at Greenwich, close to the River Thames. It was erected in two sections, and the site covers an area of approximately 3¾ acres. The plant contains four vertical reciprocating engines coupled to three-phase generators, of 3000 kw. capacity each, and four three-phase turbo-generators each of 5000 kw. capacity. Two of the latter have only recently been installed. They were manufactured by the British Westinghouse Electric & Manufacturing Co. and are shown in the accompanying photograph.

The normal capacity of the Greenwich generating station is 34,000 kw. The current is generated at a pressure of 6600 volts and is conveyed to various substations over the tramway area. The substations are provided with motor-generators and rotary converters having a total capacity of 45,750 kw. transforming the current from alternating to direct at from 550 to 600 volts.

Paraffin Motor Driven Launch

A motor launch has recently been built to the design of John I. Thornycroft & Co., London, for use in Australian waters, especially designed for both pleasure cruising and carrying bales of wool. Hatches are fitted over the stern tubes and propellers to facilitate inspection, and are made large enough to admit 34-in. bales in case of emergency.

Her length is 60 ft., with a 10-ft. beam and a draft not exceeding 18 in. She is equipped with two sets of Thornycroft six-cylinder 4½x6-in. paraffin motors, developing 45 brake horsepower, and has a speed of 13 miles per hour. The main fuel tanks are of 60 gal. capacity. A large dynamo set driven from the main engines furnishes current for a powerful searchlight, the ventilating fans and general illumination.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Hydro-Electric Irrigation Project

By H. B. McDermid

In the southeastern part of Idaho, lying on both sides of the Snake River, is the Minidoka project of the United States Reclamation Service. There are now under the ditches about 120,000 acres of land, served by several hundred miles of irrigation canals, operating for the most part under the gravity system. There is, however, a considerable acreage in that locality to which water can be brought only by a pumping system, about 50,000 acres now being supplied by three pumping stations operating in series. Each of these has a lift of 31 ft., the first taking its water from the main south-side gravity canal, at a point some 15 miles from the dam; the second, taking its suction from the discharge canal of the first station and at a point about a mile from the latter and delivering to the third level; half a mile further on, the third station takes its suction and raises another portion to the fourth and final level of the development as at present completed.

The power for these stations is furnished by the generating plant at the dam, some 15 miles to the northeast, from which it is transmitted at 33,000 volts. The capacity of the hydro-electric installation is 10,000 hp., practically all of which is utilized by the pumping stations mentioned.

Hydraulic Features

The dam, which serves both to divert the water for the two main gravity canals, one on each side of the river, and to furnish power for the pumping plants and the towns within the project area, is six miles southwest of the village of Minidoka on the Oregon Short Line, this station being the nearest shipping point.

The out-cropping lava-rock ledges, so prevalent in this locality, have been taken advantage of by the engineers in building the dam, and particularly the spillway shown in Fig. 1. A sinuous ledge of rock stretching across the valley has been utilized to form a portion of the retaining walls, thus affording a bed-rock foundation for all concrete work and effecting a considerable saving in the amount of concrete used over that which would have been necessary had the dam and spillway been built straight across the deeper portions of the valley.

In choosing the power-house equipment, several points had to be carefully considered. First of these was the normal efficiency of the turbines chosen at the head of 46 ft. Since the beginning of the official gaging of the river, it has been known to have a minimum flow less than that required for the present development, and not only must the government adopt all means to protect the water rights of the settlers it has induced to take up land there, but the prior rights of other irrigation projects farther down the river must also be supplied. Except for a short period in the summer season, this has so far been completely taken care of by ample pondage resources and the supply for the past seven years has been more than sufficient. This positive requirement is of advantage at the Minidoka dam as it insures a minimum amount of water available for power purposes of approximately 3000 cu.ft. per second as long as the natural flow of the river reaches that amount. Second, machinery had to be selected which would occupy the least floor space, as the space available was fixed by the penstock openings in the dam and horizontal units would have required a much wider building. This would have greatly increased the cost because the power house is situated in the middle of a large arid region several miles from the nearest railroad, with no dependable supply of labor available and with excessive cartage costs. A third factor governing the choice was that of the reliability of the apparatus, it being necessary to keep up the service at all times without interruption.

A careful study of these conditions resulted in the adoption of the vertical type of unit, the snail-shell type of hydraulic turbine, with sheet-steel casings, because of the high efficiencies obtainable under the moderate head conditions and the durability of the material, and, third, the installation of sufficient spare apparatus to enable continuous operation through a period of interruption.

The apparatus consists of five main units arranged as shown in Fig. 2, each unit being capable of developing 2000 hp. under normal conditions, and having an independent transformer. Each unit also has its own governor so as to secure accurate and separate control. Two duplicate exciter units, each sufficient to furnish excitation for the whole system, are installed.

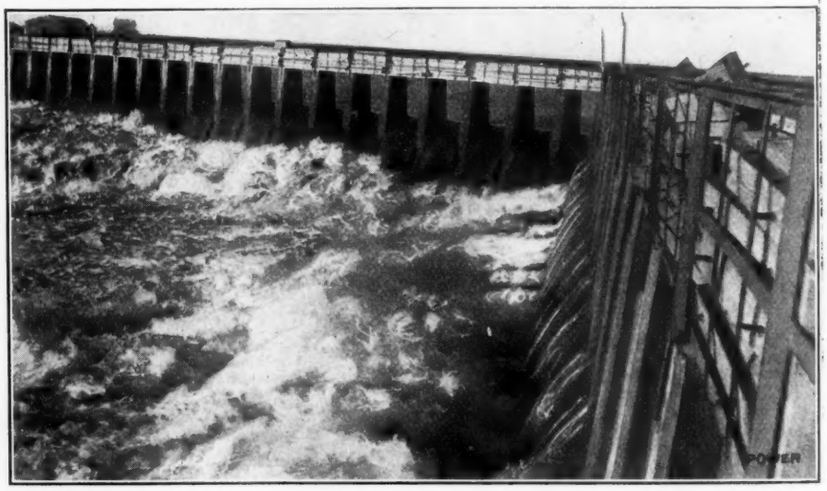


Fig. 1. Portion of 2600-ft. Spillway

The turbines driving the main units are fed by 10-ft. penstocks leading through the vertical wall of the dam, which forms one side of the power house. These penstocks are furnished with large motor-operated gate valves of the single-seat type, which are controlled from the main operating floor, directly in front of the unit whose penstock is controlled thereby. During the operation of opening a main gate, a small filler gate acting as a sort of pilot valve is also opened and the turbine and its penstock are filled, thus equalizing the pressures on each side of the main gate so that it can be raised more easily.

When the filler gates reach their full open position, they engage with a heavy

boss on the main gate and at the same time automatically throw out a limit switch, stopping the hoisting motor. The first three notches of the controller are so wired as to bridge over this first limit switch so that when a "telltale" pipe shows that the turbine case is filled, the operator may again start his motor. This again raises the valve stems, which, as they now solidly engage with the main gate, raise the latter to its full open position, when a second limit switch is automatically thrown, thus cutting off all current and making overrunning impossible.

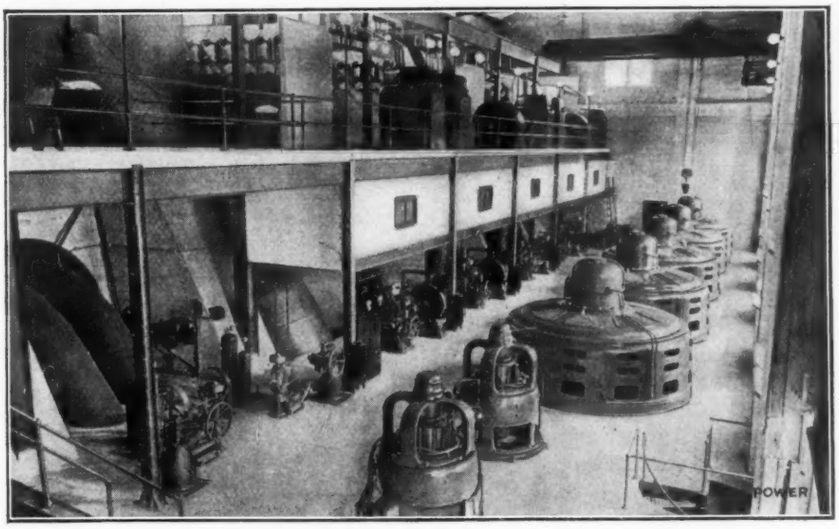


FIG. 2. MAIN GENERATOR ROOM AND SWITCH GALLERY

On lowering the gate the main gate closes by gravity, after which the filler gates close as the stems proceed on their downward travel. A glance at the sketch (Fig. 3) should make the design of the two gates clear; the whole apparatus being so designed and installed as to automatically eliminate danger from careless operating. As a further precaution, a suitable weight-and-pulley device connected to the gate and having its graduated scale directly in front of the operator is installed, thus permitting him to see at a glance the position of the main gate at any time.

The turbines are of the Francis type, with 52½-in. runners, controlled by wicket gates. They are guaranteed to operate under a normal head of 46 ft. with a maximum efficiency of 81.5 per cent.; to maintain an average efficiency of 77 per cent. from half to full gate openings, and to deliver 2000 b.hp. at the stated head. In practice, however, they are capable of delivering 2060 b.hp. and the efficiency guarantee has also been exceeded.

The sheet-steel casings are heavily stayed throughout and are rigidly supported on heavy concrete foundations which permit them to operate with minimum jar and vibration when running at their normal speed of 200 r.p.m.

The arrangement of the draft tubes is worthy of notice. In building the dam large sluice gates to take care of the overflow were installed in each main bay directly back of the draft tubes. As there might be serious risk of injury to the draft tubes if a sluice gate were opened while they were in place, an overhead trolley is arranged over each of the 10,000-lb. steel draft tubes (see Fig. 4), so that they may be detached and run out of the bay and under swinging wall cranes mounted on the down-stream wall of the power house, thus being raised up and swung around, entirely free from all danger of injury when the sluice gates are opened.

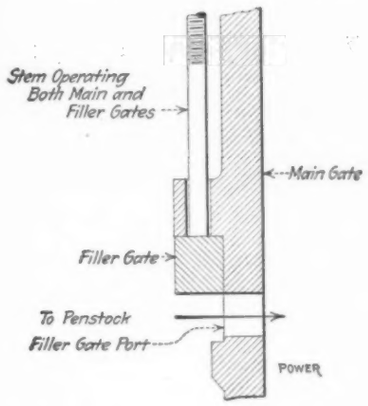


FIG. 3. SHOWING DESIGN OF MAIN AND FILLER GATES

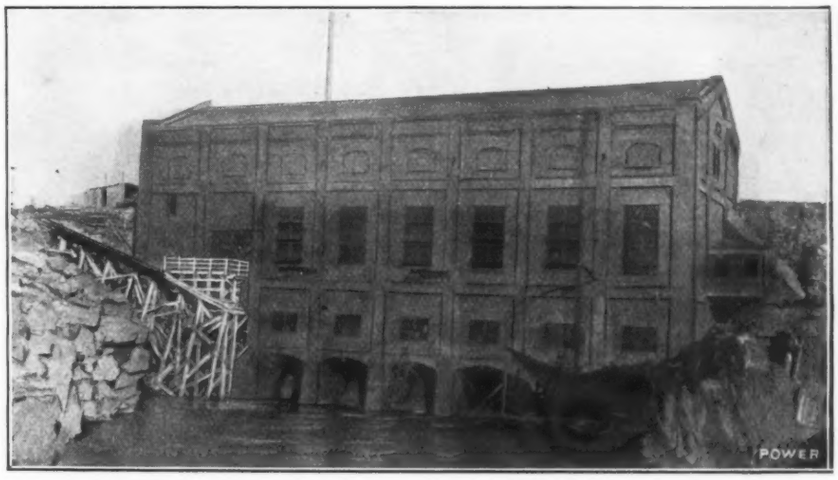


FIG. 4. DOWN-STREAM SIDE OF POWER HOUSE, SHOWING DRAFT TUBE REMOVED

REGULATION

Each unit is regulated by an oil-pressure governor the operating cylinder of which is coupled to the wicket gates of the turbine by rigidly connected links and levers. (See Figs. 5 and 6.) The regulating cylinders are supplied with a medium-weight engine lubricating oil at 175 lb. pressure by a gear pump having sufficient capacity to supply the whole station, while a second pumping unit is held in reserve.

Both these pumps are of the cycloidal type, their working parts being limited to two gears running together in a casing with the minimum possible working clearance. The oil is drawn up from the suction openings into the spaces between the teeth of the gears, and is there held by the closely fitting casing until it emerges into the discharge opening where it is prevented from escaping by the meshing of the teeth. A glance at Fig. 7 will make this design clear.

From the pumps, whose absence of valves or other small parts renders them almost immune from operating troubles, the oil is led to a pressure tank of about four barrels capacity, capable of withstanding a working pressure of 250 lb. per square inch. Normally, the upper half of this tank is filled with air which serves as a reservoir of energy, by which means the flow of oil may be rapidly accelerated to any point in the line should sudden demands be made upon the system. Since the oil pumps are of the constant-capacity type,

a relief valve is placed upon the pressure tank which opens at any predetermined pressure and automatically discharges any excess oil to the large exhaust header, conveying all oil exhausted from either the governors or the pumps to the storage tank in the basement. After it has been strained and cooled, the pump suctions take their supply. In normal operation, the oil from the pressure tanks flows into a long pressure header running the whole length of the five units, from which risers are taken off to supply each governor, the exhaust from which is conveyed through a similar header to the storage tank in the same manner as the exhaust from the relief valves.

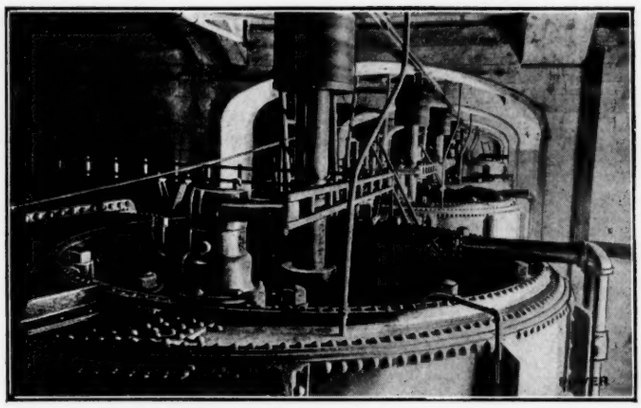


FIG. 5. SHOWING METHOD OF CONTROL ON MAIN UNITS

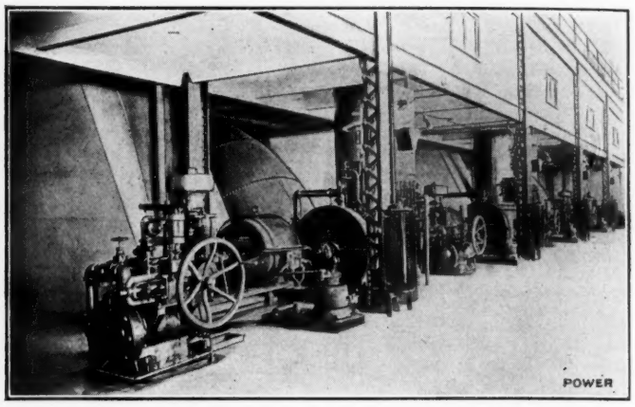


FIG. 6. GOVERNORS AND OIL PUMPS

ELECTRICAL EQUIPMENT

The main generators are of the mushroom type, furnishing 60-cycle, three-phase currents at 2300 volts. Their normal rated capacity is 1400 kv.-a. at a speed of 200 r.p.m. with a guaranteed efficiency at full load of 96 per cent. Each is direct connected to its turbine by a clamp coupling and carries upon its frame at the top of the shaft the thrust bearing which supports the 21 tons of revolving parts. This is a plain collar bearing running in a simple water-cooled oil bath, which operates without attention.

The transformers, which are located in the gallery, are air-cooled and are each rated at 1400 kv.-a. These step up the current from 2300 to 33,000 volts. It is then conveyed by duplicate sets of busbars to the remote-controlled oil switches. These switches on the high-tension circuits furnish the means for synchronizing the main units, there being no switches provided on the low-tension side of the transformers. From these switches the current may be delivered from either set of busbars to either of two transmission lines, each provided with a set of electrolytic lightning arresters. The remote-control switchboard is shown in Fig. 8, and Fig. 9 shows the disconnecting and oil switches.

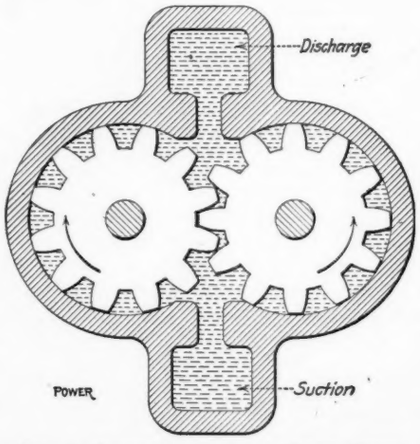


FIG. 7. SECTION THROUGH GEAR PUMP

The exciter units are driven by 180-hp. turbines of the same general type as the main units, and are furnished in duplicate throughout.

LURBICATION SYSTEM

A storage tank, situated near the upper entrance of the power house, well above the bearings to be oiled, contains a supply of oil which is led to the different units in brass pipes, and after running through the bearings is collected by centrifugal oil throwers which discharge into circular catch basins surrounding the shafts of the main units. From these, drain pipes convey the oil to a filter, where it is again pumped to the overhead storage tank by a small motor-driven cycloidal pump. This motor is stopped and started by a float-operated switch, and the entire apparatus demands but little attention. A single stop-cock, to be opened or closed as the machine is started or stopped, controls the lubrication of the main steady bearings of its unit, except the turbine steady bearing which is fed by grease cups.

The turbines, thrust bearings on top of the generators, air-blast transformers and centrifugal pumps were furnished by the Allis-Chalmers Co., the generators, motors and other electrical apparatus by the Westinghouse Electric & Manufacturing Co., and the head gates by the S. Morgan Smith Co.

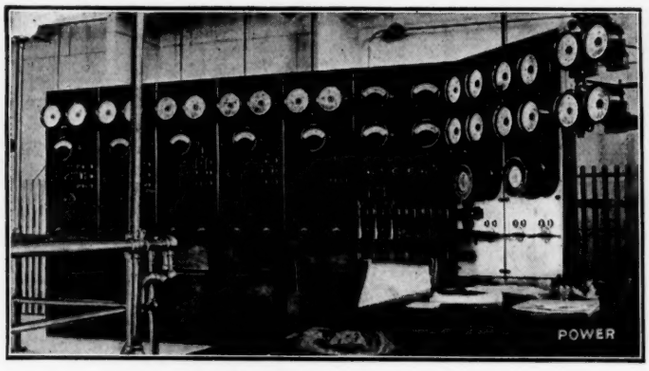


FIG. 8. REMOTE CONTROL SWITCHBOARD

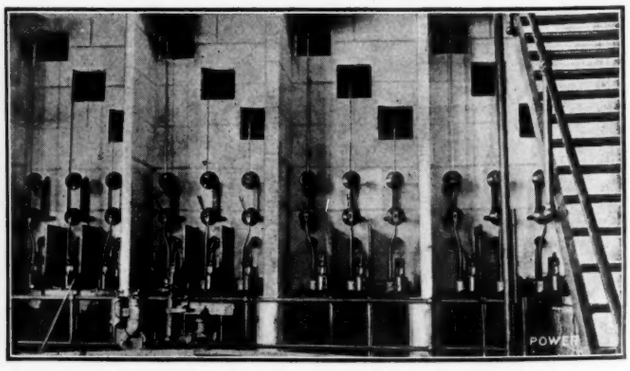


FIG. 9. HIGH-TENSION SWITCHES

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

The Foos Ignition System

The Foos Gas Engine Co. has abandoned the use of batteries and other independent sources of ignition current, and placed its entire dependence on a magneto which is attached permanently to the engine frame as shown in the accompanying picture, Fig. 1. The magneto is practically an integral part of the engine—just as much so as the governor, lubricator or other devices which though not component parts of the power-developing structure are indispensable to its operation and may be regarded as "integral" auxiliaries.

As the illustration indicates, the magneto is gear-driven from the half-time gear of the valve-mechanism shaft. It is made unusually powerful in order to enable it to give sufficient voltage to form a good ignition spark at the slow speed obtained in turning the engine over for starting up. The field magnet is made up of six permanent magnets, each $\frac{5}{16}$ x 1½ in. in cross-section, and the armature core is laminated, like that of a high-grade electric motor or generator. The machine delivers alternating current and is so synchronized with the engine through the gearing that the voltage peaks occur at the proper instants for ignition. No contact breaker is used, and the current is delivered through brushes bearing on smooth steel collector rings.

The igniter is of the make-and-break class with wiper contacts, the moving electrode being given a continuous rotary motion instead of the usual oscillating movement. Fig. 2 illustrates the construction; the spindle of the rotating electrode carries a contact blade set so that its contact edge is eccentric with respect to the axis of the spindle, and as the latter revolves, the blade wipes the tip of a flat spring which constitutes the other electrode of the igniter. This arrangement has two obvious features of merit: the wiping contact keeps the electrodes free from deposits of carbon or other objectionable material and the release of the spring by the travel of the stud causes the former to open the circuit with a sudden snap conducive to maximum vigor in the resulting spark.

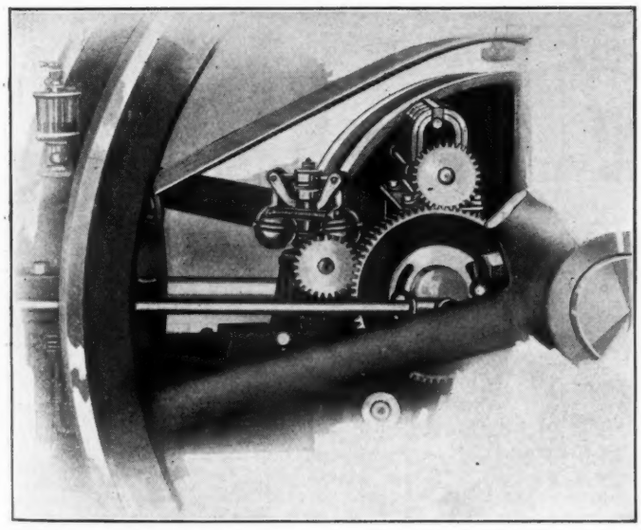


FIG. 1. MOUNTING OF FOOS MAGNETO

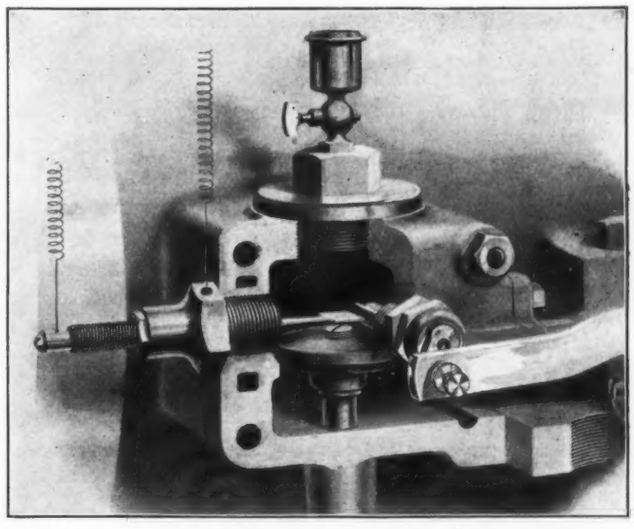


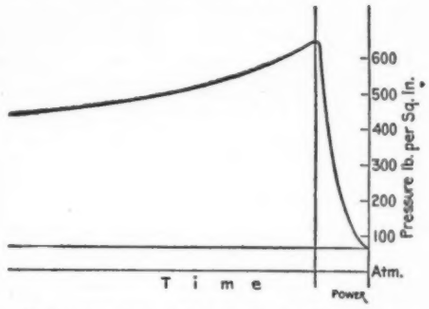
FIG. 2. THE IGNITER

Explosive Pressures in Gas Engines

BY G. W. MUNRO

The reports of the increasing number of gasoline-engine explosions lead to the belief that the designers of this class of machinery are not familiar with the pressures which may be developed by the explosive combustion of gasoline and air under favorable conditions, and consequently are making engines too light to withstand the pressures sometimes found.

The accompanying illustration shows a pressure-time diagram of an explosion of gasoline and air mixture under constant-volume conditions. The diagram was taken with a Crosby gas-engine indicator, equipped with a 280-lb. spring, the drum being driven by a descending weight, which closed the electric circuit and fired the charge at the proper time. The spring subsequently tested showed substantial accuracy. The ratio of the mixture was 1 of gasoline to 8¼ of air by weight, the initial pressure being 68 lb. above atmosphere and initial temperature 129 deg. F.



PRESSURE-TIME DIAGRAM OF EXPLOSION

The final pressure as measured on the original diagram is 645 lb. above atmosphere, an increase of 577 lb. during the fifteenth of a second the combustion lasted. Should this occur in a gas-engine cylinder 6½ in. in diameter, a total pressure of over 21,000 lb. on the piston might result in the wrecking of a light or poorly constructed engine.

That the accompanying diagram is representative rather than abnormal is shown by the fact that three other dia-

grams gave pressure rises of over 500 lb., eight diagrams rises of 475 to 500 lb., and nearly all mixtures tried of whatever ratio gave pressure increases well above 400 lb. That such results are not shown by the ordinary gas-engine indicator diagram is probably due to the fact that in the process of compression in a gas engine the temperature becomes much higher than in the experimental work, where the iron cylinder containing the mixture was heated by a torch. This results in a smaller concentration of the charge and correspondingly lower pressures in the engine cylinder.

Nevertheless, the greater concentration may sometimes be attained in practice, particularly with the engine cold.

LETTERS

An Automatic Engine Stop

The accompanying sketch represents an automatic circuit-breaker I had occasion to rig up on a gas engine driving a deep-well pump that was not fitted with a bypass on the discharge line. There were times when the engine would be forgotten and the pressure would run up dangerously high, and the pump was so placed that it was almost impossible to install a bypass. Although the circuit-breaker may be an old idea, it serves the purpose; the pressure limit never varies a pound.

I dismantled an old pressure gage and attached the tube *B* to the side outlet of a tee in the pipe leading to the tank pressure gage; then pinned the head end

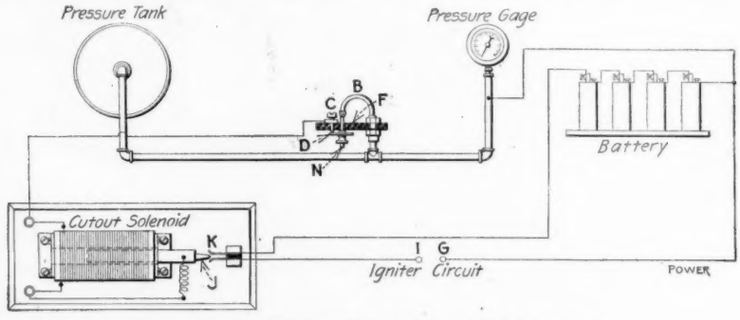


DIAGRAM OF CONNECTIONS TO CIRCUIT-BREAKER

of a screw to the toe of the tube and mounted on the other end of the screw a contact disk *D*, backed up by a locknut *N*. Then I mounted a fiber block *F* on the pipe connection at the base of the bourdon tube to provide a support for the stationary contact *C*, which consists of a screw set in the fiber and a nut to jam the screw where it is set and to hold the end of a wire leading to a cutout solenoid. The screw carrying the disk *D* passes through a hole in the fiber with ample clearance. On the end of the solenoid plunger I mounted a contact blade *J*, fitted to enter the spring clips *K*, which are insulated from each other.

Following the connections will show that the screw *C* and disk *D* control the circuit to one terminal of the solenoid winding and the blade *J* and clips *K* control the circuit to the igniter and the other solenoid terminal. Normally, the disk *D* is not in contact with the screw *C*, but the blade *J* is between the clips *K*, being set there by hand. The terminal *I* is connected to the insulated electrode of the igniter and the terminal *G* to the uninsulated electrode in order to prevent a short-circuit through the path between the pressure tank and the engine frame.

When the pressure rises to a set point, the bourdon tube draws the contact disk against the screw *C*, closing the battery circuit to the solenoid, which pulls the blade *J* out of the clips, opening the ignition circuit and the circuit to the solenoid winding at the same time. The reason for having the solenoid circuit broken at the same time is that the contact points *C* and *D* do not open until some time after the pump stops, and there would be a useless drain on the battery during that period.

N. E. WOOLMAN.

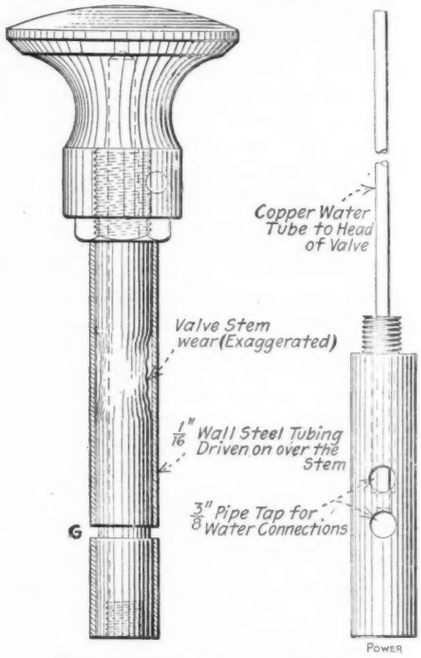
Danbury, Iowa.

Repairing and Improving Exhaust Valve Stems

When I took charge of the plant here, the exhaust-valve stems of our vertical producer-gas engines were badly worn where they pass through the packing glands, and they were also loose in the guide bushings, making considerable racket when opening and closing. To correct these conditions I made new valve stems of steel tubing of the same inside and outside diameter as the old stems, threading the ends of the new stems to fit the holes in the old heads and securing the union by means of a jam nut and a pin, as shown in the drawing. In the lower end of each valve stem I cut an internal thread to receive an extension piece in which a copper water tube is fastened and to which the water connections are made; this extension piece is shown alongside the valve stem. Then I cut a groove, *G*, near the end of the stem to take a split collar for taking the thrust of the valve spring. This gave me new valves at considerably less cost than buying them.

Now, when a stem becomes worn from the action of the sulphur in the gas and bad water, I take off the extension piece of the stem, turn the stem from the jam nut down to the end and drive on a piece of thin, hard steel tubing of the right length, as indicated in the drawing, which makes the stem of the same diameter as before; then I cut through to the split-collar groove, in the stem, put back the extension water-connection piece, and I have a good stem again. When the tubing becomes worn, I split it off and drive on another piece, and while I have the valve in the lathe I usually reface the disk true with the stem.

Another practice I have adopted to lengthen the life of the stems is to make


Copper Water Tube to Head of Valve
Valve Stem Wear (Exaggerated)
1/16" Wall Steel Tubing Driven on over the Stem
3/8" Pipe Tap for Water Connections
G
POWER

REPAIRED EXHAUST-VALVE STEM

new water-connection extension pieces long enough to reach into the lower guide bushings, cut off the push rods and take off the caps over the ends of the push rods that held the adjusting liners; the liners are put in the lower guide bushing, between the end of the valve stem and the push rod. This prevents the lower end of the stem from jumping around when the packing wears, and keeps the stem in line with the axis of the seat.

I have also arranged the water connection to the exhaust valve to take warm water from the jackets instead of using cold water, thereby preventing sweating and considerable wear. The guide bushings for the exhaust-valve stems were also found to be worn, so they were bored out 1/8 in. larger and babbitted to the proper size; they are still in use. I use a mixture of grease and graphite for lubricating the stems, with forced feed.

J. W. FRIES.

Middleboro, Mass.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Vacuo Hot Water Heating*

By Ira N. Evans

Much of the material in the first part of this paper has been previously covered in Power in the series of articles on hot-water heating and may therefore be passed over to the latter part of the paper which deals with a steam-turbine plant under variable load supplying steam to the heating system. A similar problem with the turbine under constant load has been considered in the series of articles just referred to. See p. 419, Sept. 12, 1911.

For a variable load, such as is considered in this paper, a chart should be worked out for the heating in pounds of steam, and one for the daily load, showing the average hourly variations for 24 hr. With pounds of steam as ordinates and hours as abscissas, the curves of steam consumption for each 5 in. of vacuum between full vacuum and atmosphere should be plotted for the engine or turbine for the average daily load, showing the hourly variations. From these charts another should be constructed for each 10-deg. period from 0 to 60 deg. with pounds of steam as ordinates and hours as abscissas. Each chart will have four curves: the typical curve of temperature outside, showing the hourly variation; the turbine steam consumption at full vacuum; the heating curve in pounds of steam, and the curve of actual steam consumption of the turbine at the hourly loads.

*Excerpt from paper read before the American Society of Heating and Ventilating Engineers, New York City, Jan. 25, 1912.

By dividing the hours, Table 2, by 24, the number of days can be obtained for each 10-deg. period of temperature. When the areas between the curves on each of the six charts are determined and multiplied by the number of days in each case, the heating, excess steam and cost of reducing vacuum can be determined for the season.

Heating and power curves together with the steam consumption are worked out in Figs. 1 to 8, and Tables 1, 2 and 3 for the entire heating season with the variable power load as it actually occurred.

Fig. 3 gives the operation of a hot-water system for weather 0 to 10 deg. outside. It also gives the typical conditions of operation as they would occur on a vacuum system of steam heating. The hatched spaces would show the steam wasted to the atmosphere through the relief valve. As the heating system cannot be operated with steam much below 212 deg., the curve *H* would give the steam requirements on a vacuum system without allowances for condensation losses. This condition would be nearly constant throughout the entire heating season.

If the load on the plant was such as to supply only exhaust steam enough to balance the heating from 5 p.m. to 8 a.m., allowing no exhaust steam to escape to the atmosphere at those periods, live steam would have to be used from 8 a.m. to 4 p.m. This is generally the period of highest temperatures during the day and highest water temperature for heating. A slight decrease in vacuum

TABLE 1. HEAT DEMAND AND SUPPLY, HOBOKEN TERMINAL, LACKAWANNA RAILROAD

		S	*R*	*D*	*V*	*L*	*H*		*T*	*T*—*T'*	*T*—*H*
Outside Temperature, Degrees F.		Supply Therm., Deg. F.	Return Therm., Deg. F.	Dif. Temp., Deg. F.	Max. Vac.	Latent Heat,* B.t.u.	Lb. Steam per Hour, $\frac{1{,}158{,}700}{L} \times D$	400 Kw. *T* Rate	Lb. Steam, 400-Kw. Load	Cost Operated Red. Vac., Lb. Steam	Surplus Steam, Lb.
1	0– 5	211.1	197	14.1	3 lb.	960	17,020	47	18,800	10,560	1780
2	5–10	206	192.6	13.4	0	966	16,073	43	17,200	8,960	1127
3	10–15	200	187.3	12.7	3″	969	15,187	41	16,400	8,160	1213
4	15–20	194.5	182.5	12	6.4″	973	14,292	38.8	15,520	7,280	1228
5	20–25	188.3	177–	11.3	9″	977	13,402	37	14,800	6,560	1398
6	25–30	181.6	171–	10.6	11.5″	981	12,520	35.2	14,080	5,840	1560
7	30–35	174.9	165	9.9	14″	986	11,654	33.5	13,400	5,160	1746
8	35–40	167.8	158.5	9.3	17″	993	10,853	31.4	12,560	4,320	1707
9	40–45	158.5	150	8.5	19.5″	1000	9,851	29.5	11,800	3,560	1949
10	45–50	146.6	139	7.6	22″	1007	8,745	27.3	10,920	2,680	2175
11	50–55	133	126.5	6.5	24.2″	1016	7,412	25.2	10,080	1,840	2668
12	55–60	117.5	112	5.5	26.2″	1027	6,205	23	9,200	960	2995
13					2″			20.6	8,240		

1,158,700 lb. water circulated per hour. *Old values used before Marks and Davis tables were adopted.

TABLE 2. NUMBER OF HOURS FOR EACH 10 DEG. PERIOD OF TEMPERATURE FROM 0 TO 60 DEG., NEW YORK DISTRICT

Month	Week Days												Holidays, Sundays											
	"A" Days 7 a.m. to 5 p.m.						"B" Nights. 5 p.m. to 7 a.m.						"C" Days 7 a.m. to 5 p.m.						"D" Nights. 5 p.m. to 7 a.m.					
	0°-10°	10°-20°	20°-30°	30°-40°	40°-50°	50°-60°	0°-10°	10°-20°	20°-30°	30°-40°	40°-50°	50°-60°	0°-10°	10°-20°	20°-30°	30°-40°	40°-50°	50°-60°	0°-10°	10°-20°	20°-30°	30°-40°	40°-50°	50°-60°
Oct.				5	35	85					56	140					10	30				28	21	63
Nov.				90	105	20				168	105	14				35	45					119	14	
Dec.		25	100	80	20			70	175	28	14			15	45	10	15			56	70	14		
Jan.		10	60	135	25		28	14	84	161	14			5	25	35	15			7	10	56		
Feb.	10	15	40	95	35	15	14	28	70	105	28	21		5	40	25			14	14	84		14	
Mar.			5	90	90	55			21	168	84	49				5	35	15					42	70–
April.				5	35	155				14	133	154					10	40					70	42
May					5	100					28	154						25					28	28
Total.	10	50	205	500	350	430	42	112	350	644	462	532		25	110	110	130	110	14	77	164	217	189	2038
Per cent.	0.19	0.99	4.07	9.94	6.95	8.54	0.83	2.23	6.95	12.8	9.2	10.6		0.5	2.19	2.19	2.58	2.19	0.27	1.53	3.26	4.3	3.76	4.04
Total.	1545 hr. 30.68 per cent.						2142 hr. 42.6 per cent.						485 hr. 9.65 per cent.						864 hr. 17.16 per cent.					
													3491 hr. 69.32 per cent.											

at these periods of light load on the vacuo-water system eliminates the use of live steam at that time.

If the plant were arranged for a vacuum system requiring steam as per Fig. 3, curve *H*, there would be no saving in operating the plant condensing, as the steam would be required for heating at all times.

On the other hand, if the engines were operated noncondensing, according to curve *T*, Fig. 3, there would be no saving in operating a hot-water plant, as the steam consumption would be required for power regardless of the heating system. There would be a saving with the hot-water system if the power was insufficient to balance the heating and during periods of live-steam operation when the engines were shut down.

By placing a vacuum on the engines the full capacity of the heating system as a condenser is obtained for practically no expense and as the heating and power load reach a balance the amount of exhaust steam is reduced and the steam consumption of the heating system is lessened at the same time. When the power load on the unit is not reduced to the balanced quantity or the excess steam spaces not taken care of by the condenser, the water in the heating system becomes heated very quickly and the condensing effect destroyed. This is where the saving on the combination is effected.

In cases where no condenser is available the power load on the engine can be reduced by regulating the vacuum and water temperature and producing the same result. The power not needed for heating should be turned out doors. In this manner a lower rate per kilowatt-hour would be obtained for the engine operated on the heating system than the units exhausted to the atmosphere.

By this arrangement there is no reason why all hot-water heating plants should not be operated under vacuum on the portion used for exhaust-steam heating. It is simply a question whether the remainder of the power load is sufficient in quantity to warrant a condensing outfit.

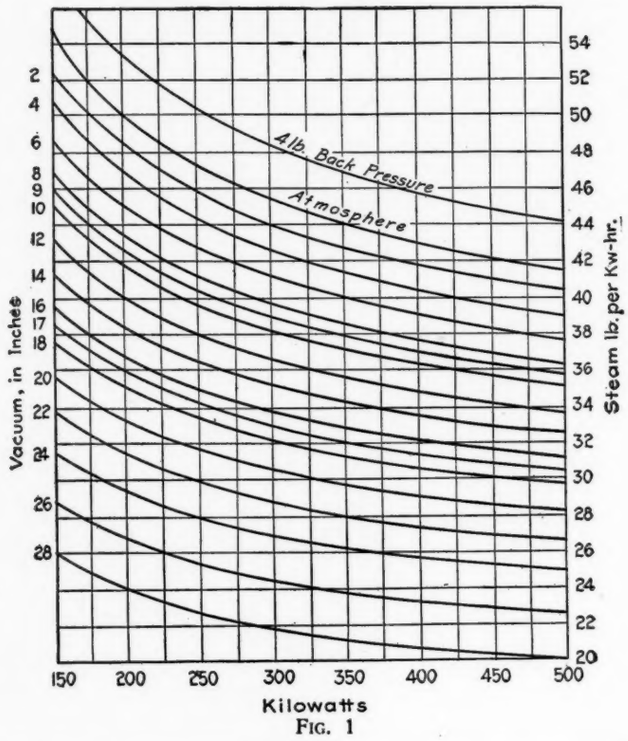


FIG. 1

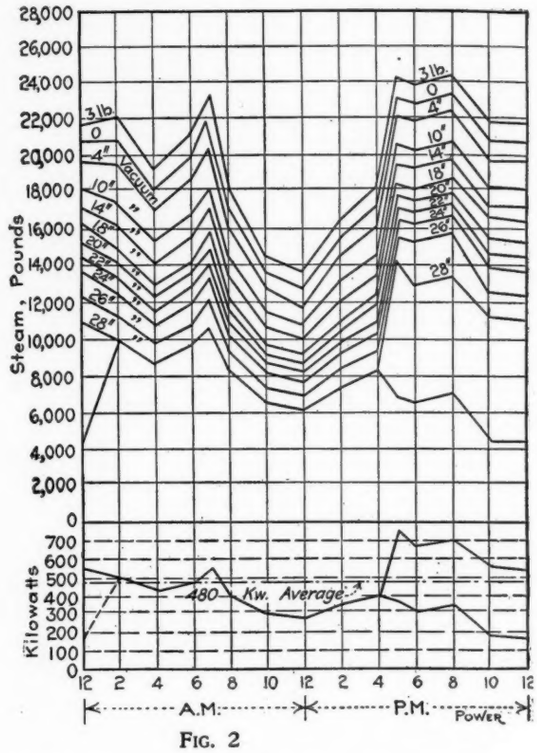


FIG. 2

By dividing the total steam for power and heating, Table 3, or 68,870,482 lb., by 209.79 days, the average daily load for power and heating will be found to be 328,000 lb. per day. This shows that Figs. 6 and 7 will give the average condition on a hot-water system that would require the same steam and operating conditions as a vacuum system at 0 to 10 deg., as in Fig. 3. These charts show a vacuum of from 18 to 20 in.

The average heating ordinate for Figs. 6 and 7 from Table 3 is about 10,000 lb. per hour against 15,000 lb. for Fig. 3. This means that if the power was only sufficient to furnish 10,000 lb. of steam a vacuum could be carried all the time and the heating accomplished with hot

TABLE 3. DATA OBTAINED FROM PAGES 1 TO 8

Outside Temperature, Degrees F.	Days	Curve *H*		Curve *T*		$\frac{T}{(H \text{ or } T')}$		Average Ordinates			
		Heating per Day, Lb. Steam	Total Steam Heating, Lb.	Steam Power and Heat per Day, Lb.	Total Steam Heat and Power, Lb.	Excess Steam, Lb.	Total Excess Steam, Lb.	Power and Heating, Lb. Steam	Heating, Lb. Steam	Excess, Lb. Steam	Steam, Rate per Kw.-hr.
0–10	2.75	374,500	1,029,875	440,000	1,210,000	65,600	180,400	18,333	15,604	2733	38.2
10–20	11–	353,600	3,889,600	428,800	4,766,800	75,200	827,200	17,856	14,733	3133	37.2
20–30	34.5	314,240	10,841,280	385,600	13,303,200	69,120	2,384,640	16,070	13,100	2900	33.5
30–40	61.3	277,440	16,820,720	348,800	21,381,440	74,400	4,560,720	14,533	11,433	3100	30.3
40–50	47.12	224,640	10,585,040	307,520	14,490,342	63,200	2,977,984	12,813	9,360	2633	26.7
50–60	53.12	157,120	8,346,214	259,200	13,768,700	27,840	147,886	10,800	6,550	1160	22.7
Totals.....	209.79	.....	51,512,729	.....	68,870,482	.....	11,078,830	.....	.....	....	....

Average power, 480 kw.
228,800 lb. per 24 hours. Curve *T*".
20 lb. per kw.-hr. @ 28-in. vacuum

For 209.79 days × 480 kw. × 24 = 2,416,800 kw.-hr.

$$\frac{68,870,482}{2,416,800} = 28.5 \text{ lb. per kw. average rate}$$

water with a very small amount of live steam. If a vacuum system were used under the same conditions 5000 lb. of live steam would be required nearly for 100 days, or 50 per cent. of the heating season.

This shows the importance of balancing the heating and power load and the fallacy of making an uneconomical power plant on a noncondensing basis simply to furnish exhaust steam for a vacuum system. The heating system should in no way influence the question whether a plant should be operated condensing or noncondensing.

Column *H* in Table 1 gives heating requirements in pounds of steam per hour for each condition of outside temperature with the maximum vacuum necessary to produce the water temperatures and maintain a constant temperature of 70 deg. in the room with the proportion of heating surface installed in this particular case. These records are plotted from recording thermometer charts covering a considerable period of time.

Fig. 1 is the steam consumption of a 500-kw. turbine unit under different loads and degrees of vacuum with steam at 150 lb. gage and 15 deg. superheat.

Fig. 2 is the steam consumption for the hourly load under different degrees of vacuum. The load varies from 200 kw. to 750 kw. with two peaks, one at 5 p.m. and one at 7 a.m. The water from the condenser was weighed and the load and the vacuum noted. These variations in load are handled entirely with two machines, and if the load was considerably increased, the charts show that the steam consumption due to the higher vacuum would be very little greater as the machines are underloaded a portion of the time. The hourly load is plotted in kilowatts at the bottom of Fig. 2 and the average hourly load is 480 kw. per hour. All areas were measured by a planimeter.

The double power curves show when two machines are operated at the peak, one under reduced vacuum for heating and one at 28 in. vacuum. The load one machine will carry at no vacuum is 375 kw., and 950 kw. has been carried a short time at 28 in. vacuum with one machine. A load of 375 kw. just balances the heating load in amount of steam and temperature by simply changing the vacuum.

Up to 30 to 40 deg. outside, Fig. 6, it is most economical to operate two machines from 4 p.m. to 2 a.m., but for Figs. 3 and 8 it is necessary only to operate two machines from 4 p.m. to 10 p.m. Except in extreme weather at low vacuums, the load is carried at all times with one machine or until the vacuum gets below 10 in. In working out the charts the minimum steam consumption will be shown by operating the two machines as indicated.

Curve *T'* is the steam consumption of the turbine under the characteristic load at 28 in. of vacuum. Curve *H* is the curve of heating corresponding to the curve of outside temperature at the bottom of each chart for a typical day for each period of 10 deg. range of outside temperature. Curve *T* gives the steam consumption of the turbine under the hourly load and vacuum which will produce the proper water temperature for curve *H*.

At the peaks the vacuum has been decreased slightly so as to improve the steam consumption. From curve *T'* at 28 in. of vacuum the area to the base line represents the steam consumption required for power if no heating were required. Curve *H* likewise incloses the area for the hot-water system, whether live steam or exhaust is used. Curve *T* gives the requirements for heating and power combined for each typical day and power load. The saving is the excess steam areas between *T* and *H* or *T'*, as the case may be deducted from the area inclosed by *T'*. All areas were read by a planimeter, and the average ordinates and results are tabulated in Table 3 and graphically in Fig. 1. It may be seen that in most cases *H* is greater than *T'*, but for the high temperatures out of doors, *T'* is frequently greater than *H*. In any case, the heating and power at full vacuum are fixed by requirements regardless of other conditions.

When less power is generated than the balanced load, the vacuum will have to be reduced, to increase the quantity of steam to maintain a proper water temperature on the heating system. It will not pay to carry normal vacuum for that outside temperature and operate the live-steam heater to furnish the additional heat, although the apparatus is arranged so that this could be done.

At noon in most cases, the vacuum is reduced below normal to furnish steam for heating on account of light load. Where this occurs on a vacuum system, the reducing valve would have to be opened to supply live steam to keep the pressure from dropping too low. The curves show that this arrangement would be ideal from an operating standpoint for a high office building and hotels where the heating load at times exceeds the power load. One turbine unit could be operated on the heating of a size to just balance the requirements of the heating system, and when the machine is underloaded the decreased vacuum would be no additional expense.

When the turbine load can be balanced against the heating, the excess steam on the charts will disappear. In this case 375 kw. just balances the heating at all outside temperatures. This would also eliminate the different-sized units to take care of the variations in

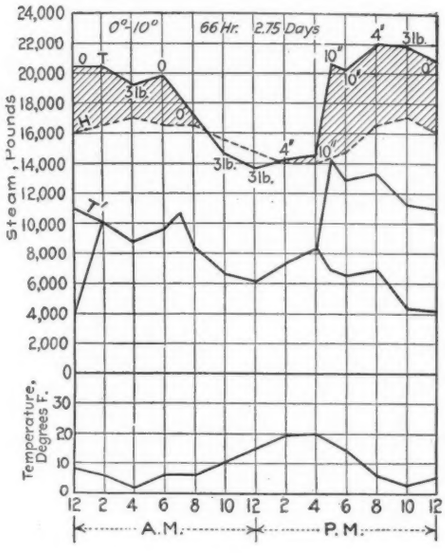


FIG. 3

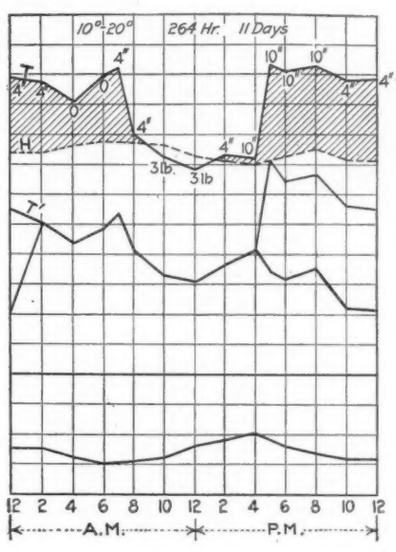


FIG. 4

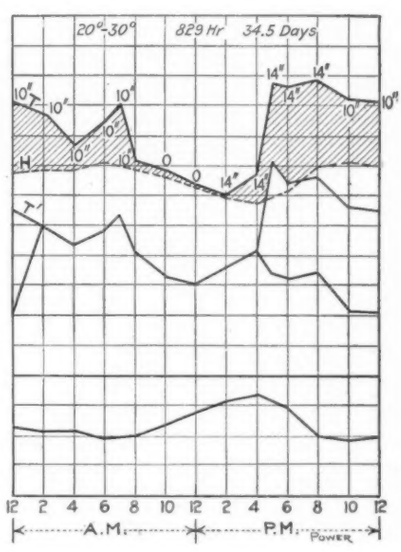


FIG. 5

load so as to obtain an economical steam consumption as in the case of reciprocating engines.

As the summer load is considerably less than the winter load, condenser capacity need be furnished to the extent only of the power installed in addition to that which will balance the heating, utilizing the vacuum that this condensing capacity will produce in summer under the reduced conditions of load. This will cut down the first cost of installation without seriously interfering with the economy. It is a question to be determined in each particular case. The only reason advanced for not operating condensing engines for large office buildings has been the requirements of the vacuum-heating system or possibly the excess of heating over power requirements. With the hot-water system as described, more than 20 in. of vacuum can be carried 80 per cent. of the time, and the heating provided for with exhaust at the same time. It will also be noted that the maximum daily temperature occurs at the time of the peak load in the New York district, which means a greater vacuum.

The operation of the plant is simple, the temperature of the return water being regulated by adjusting a single valve at intervals of two hours as the load or outside temperature changes. The curves and resulting vacuums are entirely the result of manipulating this one valve, and the hourly load at that period. The second turbine is started when necessary and the same condenser handles both machines, one exhausting direct to the condenser under full vacuum and the other to the hot-water system under reduced vacuum. Attention is called to the following facts demonstrated by Table 3 and the charts:

The heating curves show 100 per cent. range between the 0- to 10-deg. condition and the 50- to 60-deg. condition. This range is impossible on a steam system except with automatic heat control kept in operating order. If the 0- to 10-deg. condition, and 374,500 lb. of steam per day are taken for the steam consumption minimum for a vacuum system at 212 deg., the total steam consumption for 209.79 days would be 78,566,000 lb. against 51,512,729 lb., or a difference in favor of the hot water of 27,043,271 lb., which at 20c. per 1000 lb. would be a saving of $5410 per year, or 35.4 per cent. saving. This shows the saving in favor of hot water, where there is no power to be considered and live steam is utilized for heating in either case.

If 45 lb. per kilowatt-hour at the switchboard is taken for the steam consumption of the engine at atmosphere, the steam used during 209.79 days for 480 kw. average load would amount to 108,756,000 lb., which, at 20c. per 1000 lb., would cost $21,751. This does not allow for any live steam for periods of low load to keep up pressure on the heating system and preventing air leaks.

The cost of power and heating combined on the hot-water system is (68,870,482 lb. at 20c.) $13,774. This represents a saving of $7977, or 37 per cent.

The cost of operating the hot-water system on live steam and condensing the engines under full vacuum would be

$$51{,}512{,}730 + 48{,}000{,}000 = 99{,}512{,}730 \text{ lb.}$$

which at 20c. amounts to $19,903. Also,

$$99{,}512{,}730 - 68{,}870{,}482 = 30{,}642{,}248 \text{ lb.}$$

which at 20c. amounts to $6130 per heating season, or 31 per cent.

The saving effected by utilizing the turbine under partial vacuum may be found by deducting the excess steam from the steam under full vacuum or

$$48{,}000{,}000 - 11{,}078{,}830 = 36{,}921{,}170 \text{ lb.}$$

At 20c. this amounts to $7384, or 73 per cent. of the steam at full vacuum.

In case coal at a lower cost than assumed is available, a proper proportion will determine the saving. This saving is figured in fuel at $3.60 per ton and does not include city water saved in condensation or wear and tear on extra boilers and apparatus to burn the fuel.

If properly designed, a hot-water system can be installed for the same cost nearly as a low-pressure steam system if all specialties are included. The covering for risers within the building required on steam can be omitted, reducing the temperature of the water within the system by the amount corresponding. Automatic heat control can be omitted as a constant temperature in the rooms can be maintained by regulating the temperature of the water at the plant. These items of expense will more than balance the cost of the heaters and pumps. In any case, the saving capitalized would warrant a considerable expenditure in addition in favor of the water system. These savings can be taken as nearly standard percentages for any condition.

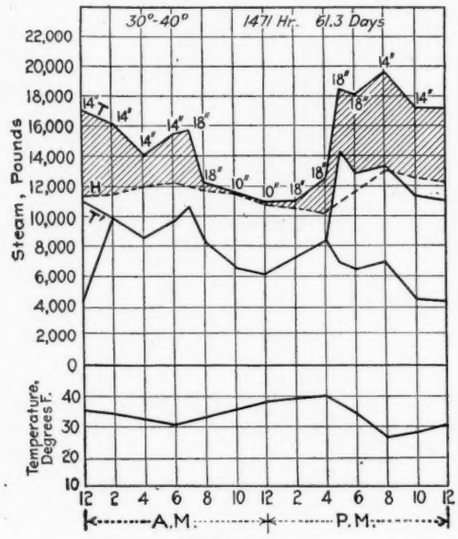


FIG. 6

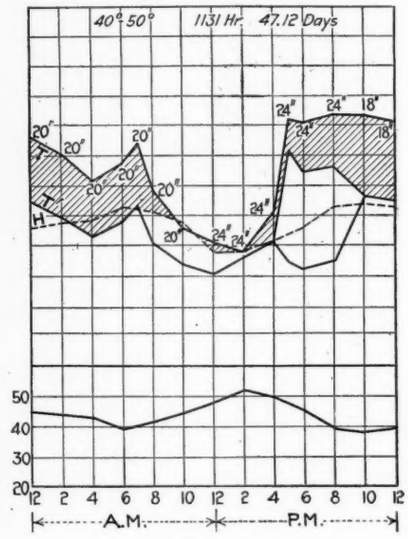


FIG. 7

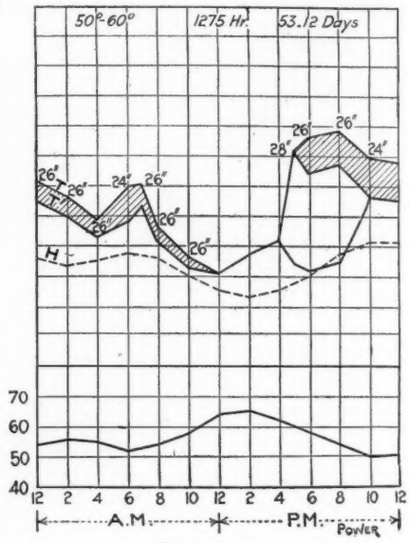


FIG. 8

Recently the Census Bureau at Washington issued a statement relative to works manufacturing locomotives.

There were 16 establishments in 1909 and 15 in 1904; in 1909 the capital invested was $52,060,000, a gain of $13,639,000, or 35 per cent., over $38,421,000 in 1904.

In 1909 the value of the products was $31,582,000, and $59,552,000 in 1904, a decrease of $27,970,000, or 47 per cent. There was added in 1909 by manufacture $16,522,000, and $31,849,000 in 1904, a decrease of $15,327,000, or 48 per cent.

For salaries and wages there were paid $11,211,000 in 1909 and $17,473,000 in 1904, a decrease of $6,262,000, or 36 per cent. The army of wage-earners numbered 14,909 in 1909, but in 1904 there were 28,806, a decrease of 40 per cent.

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POWER

The Indicator and the Orsat

A neat way of expressing their appreciation of the efforts of their engineers toward self-improvement and of aiding them to that object without being in any way patronizing, was that adopted by the manufacturers of Fitchburg, Mass., in presenting to the local engineers' association a complete indicator outfit.

There is probably no one thing that has awakened more engineers to a real live interest in the larger side of their calling than this stethoscope of the engine. Its revelations have made the internal workings of the machine so apparent, their study has led them into such pleasurable and profitable paths of study and investigation and shown so directly the bearing of the theories and principles involved upon their everyday work that it has lifted its students out of the humdrum of manual labor and started them out to be real engineers.

But far and away above the worth of the gift to the association is the significance to them of the spirit which prompted its donors. They can and will make the instrument pay big interest upon its cost to the power-plant owners who participated in its presentation; they will esteem and respond to the thoughtfulness and kindly spirit which moved somebody to think of it and the others to approve and aid in carrying out the suggestion.

There is another instrument about which the average engineer knows less than he does about the indicator. It relates to the boiler as the indicator does to the engine. By an analysis of the gases rejected at the uptake it shows how complete has been the process of combustion, how much unnecessary air has been uselessly heated up, what proportion of the heat that was in the coal is going away in the stream of gas which goes to the chimney.

As an engine is made so must it run. The most that one can do is to set its valves properly, keep it packed and lined and lubricated, and accept its results. The boiler is much more flexible. With a given installation one man may make twice as much steam per pound of coal as another. The average efficiency is probably below sixty per cent., while over eighty is attainable and attained. The processes of the boiler room are more interesting than those of the cleaner and more comfortable engine room, and an understanding of those processes and the intelligent application of that understanding promise more than any other direction in which the operating engineer's activities can be exerted.

We suggest that some other group of employers who wish to do a graceful and profitable act should present their associated engineers with a complete apparatus for sampling and analyzing flue gases with the pyrometers, thermometers, etc., necessary to determine its temperature, and furnish them with it a lecturer or instructor who would teach them how to use it and apply its indications.

The resultant interest in the problems of combustion, the ability and inclination to make a heat balance and the striving to make the "heat applied" item as large as possible would pay an enormous interest upon the investment.

Safety Precautions in Electrical Work

The advent of the steam turbine has been a large factor in introducing and promoting the use of electricity for power purposes, with the result that there are today many plants, particularly smaller ones, developing power by means of turbo-generators and then distributing this power to the various points where it is needed. This has naturally done away with the small individual steam drives so common a few years ago, and with which the operators were thoroughly familiar, and has introduced an entirely different phase in power engineering. In many instances where changes of this kind have been made, the old engineers and operators have been retained and are expected to go right along

and handle the new equipment with the same degree of skill as they did the old. To men not very familiar with this form of generation and use of power there is always more or less fear for their personal safety and often life is endangered by their ignorance as to the proper precautions to be observed in protecting themselves.

One frequently hears of electrical workers being killed by the current, and from this naturally proceeds the belief that all electric currents are dangerous and that any contact with a highly charged conductor will result in a serious, if not a fatal, shock. There is, however, considerable misunderstanding on this point. Men in charge of electrical equipment survive their constant attendance upon and care of the most dangerous machines in regular operation by simply observing certain precautions and following fixed rules so that practically all danger is removed. While it is true that it is the characteristic of pressure or voltage in an electric current that makes it dangerous, and also that this pressure must be present in order to distribute the current economically, yet it must also be remembered that such a current is harmful only if allowed to pass through the body, and in order to do this it must have a means of exit as well as one of entrance. Care must be exercised, therefore, to prevent such a possibility.

For this reason there should always be provided a dry wooden or rubber-covered platform or floor about a high-tension generator so as to give good insulation and a similar precaution should also be made in front of the switchboard. A man standing upon such a floor, provided it and his shoes are perfectly dry, cannot possibly be injured by the most vicious current should he simply touch one of the wires conveying it because his connection with any return conductor would be lacking. Dry shoes afford, in themselves, some measure of protection, as they are of an insulating material, but if they are damp or contain nails, a ready path to ground will be given to the current with possibly fatal results. When working upon or about high-tension machinery or wires, many electricians make it a rule to use one hand only, keeping the other away from the work entirely. In all cases, however, it is advisable to use rubber gloves and rubber overshoes which at least tend to protection.

Safety also demands that all wires be amply protected to prevent contact with them and also railings about the machinery and legible signs conspicuously located so that they will always be a warning. Carelessness and contempt through familiarity with electrical equipment of a dangerous nature are probably the chief causes for a majority of accidents.

The Engineers' Diary

The engineers' diary or log book fills an important place in the daily operation of the power plant. Items of interest and value for the preserving of which there is no other provision may be recorded here. In addition to the usual information given in the log or the daily data sheets, there are many items which may well be recorded, as memoranda of supplies needed, of repairs which are necessary or soon to be necessary; reports of inspections of equipment; the history of belts, packings, valves and the minor paraphernalia of the plant; observations on the performance of lubricants, chemicals for treating feed water, heat insulators and other materials; lists of materials received and used. These items are merely suggestions; the desirability of recording many others will be apparent.

The conclusions arrived at as the result of tests of the plant or equipment should also be entered here, with the changes which were suggested thereby, and summaries of the important tests should be included for convenience in making comparisons. If experiments are conducted the results should be recorded for future reference. While this information is filed in detail with the plant records, it is often not readily accessible or easily consulted. The diary will serve as a clearing house for betterment ideas.

In the event of an unusual occurrence or accident, the report of the engineer as made at the moment will furnish valuable evidence and serve as an efficient prompter to his memory should the necessity arise. The proper place for the original draft of this report would be in this diary.

It may seem that much of the information recorded has slight value when the record is made, but apparently trivial matters often assume unlooked-for importance after an interval of time. Such a record should be neatly and durably bound and fully indexed.

Some English physicians are recommending the smoky parts of Sheffield, England, for sufferers from asthma. Is this a rebuke for the smoke-abatement movement, or merely an asthmatic wheeze?

The high cost of living will doubtless be lowered in time, but the man who neglects to acquire a thorough working knowledge of his vocation will always find it hard to pay his way.

Only one flywheel explosion is listed for the United States and Canada for last November, says *Engineering News*. Was this luck, or increased care?

That over 3000 steam engineers have been graduated by one reputable correspondence school is a convincing argument of the practicability of this kind of education.

How much exhaust steam does your manager sell to nearby shops and buildings? If he does not know it is feasible, and you do, why not suggest it?

The scientists tell us that there is "a vacant space in the human head." It might be utilized as a mental repair shop if some of us were awake to our poor operating condition.

Owe no man anything but good will. If you get a helpful kink out of POWER this week, pay your indebtedness by "kinking" him back.

Now and then, POWER is asked to recommend a first-class operating engineer. Are your name and qualifications included in its list?

At a recent banquet at Cincinnati, Ohio, Mayor Baker asserted that within two years the city will own electric plants which will furnish current at, if not under, 3 cents per kilowatt-hour.

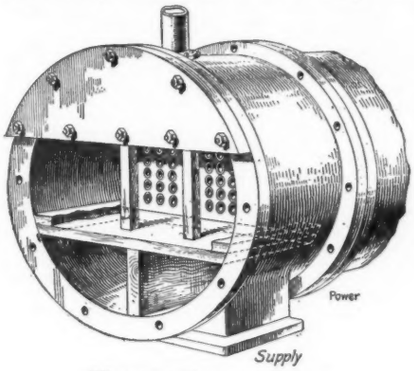
This is the season for starting up the refrigerating plant. Are you ready?

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Plank Baffle Plate

One day the vacuum dropped from 26 to 10 in. The apparatus was looked over carefully but the cause could not be found, so the engines were kept running at the lower vacuum until the following Sunday morning; we were obliged to



WOODEN BAFFLE PLATE

have them in operation again at 6 o'clock that night.

The lower part of the surface condenser head was removed and the baffle or division plate was found broken in several pieces. The chief suggested putting in a 2-in. plank; this was done, as shown in the illustration. Although this job was done three years ago, the plank is as sound as ever, and the condenser maintains between 26 and 27 in. of vacuum.

R. A. HAFFORD.

Groveton, N. H.

Wrong Receiver Piping

In a certain central station all of the condensers were located in the boiler room next to the dividing wall between the engine and boiler rooms, and it was a part of the water tender's duties to watch the condensers.

One of the units consisted of a 14 and 28 by 36-in. tandem-compound Corliss engine connected to a single-jet condenser; the top of the condenser cone was about 18 in. below the bottom of the low-pressure cylinder. There was a 1½-in. pipe from the city water main connected to the cone that was used to prime it when necessary. One day this unit was cut out in order to do a little work on it, and the attendants were standing by waiting for it to stop; they stated the engine would not have made two more revolutions, when it was wrecked by knocking out the front of the main bearing, breaking the cap and springing the shaft at the crank disk.

On investigation it was found that the 1½-in. priming valve was wide open. The receiver was set about 4 ft. to one side and under the floor in a trench dug in the ground and about 1 ft. above the bottom of the trench, as shown in the sketch. It was about 24 in. in diameter with a manhole in each end. About 18 in. from each end there was a tube sheet with four 4-in. tubes rolled in, the bottom tubes being about 5 in. from the bottom of the shell. There was a live-steam connection in the space between the tube sheets which was used as a reheater; this space also had a drain connected.

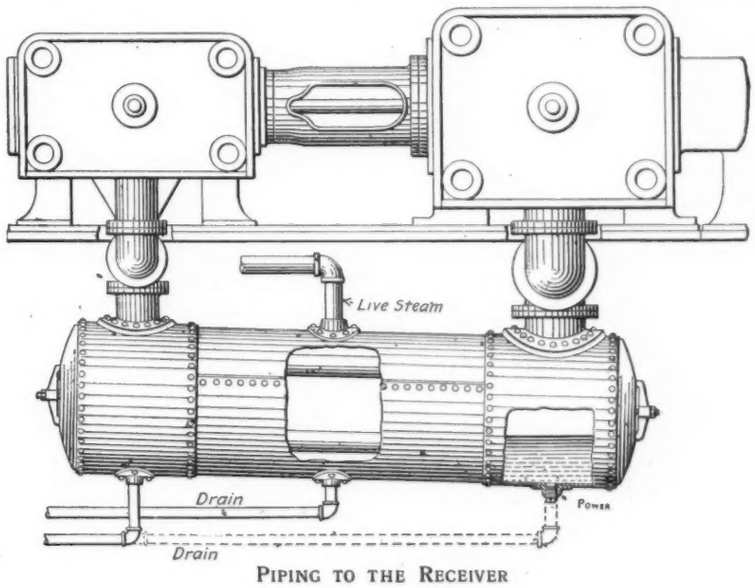
The end into which the high-pressure cylinder exhausted was drained; the other end of the receiver connecting to the low-pressure cylinder was also fitted with a drain connection, which was plugged, although that end was about 4 in. lower than the other.

One night, about three years after the first accident, in picking up this unit, when it got to about half speed, it knocked out the main bearing and broke the cap as before. When both manheads of the receiver were taken out it was found that the end next to the low-pressure cylinder was filled with water up to the bottom tubes.

That, it is supposed, is where it got its dose of water; anyway, that drain was then connected. This was negligence and carelessness in installing and operating.

L. W. RAGSDALE.

Beverly, Wash.



PIPING TO THE RECEIVER

Mistakes and Carelessness

It is a mistake to remove all of the nuts from the flange-bolts when breaking a joint, on the assumption that there is no pressure on the steam pipe. A little more time may be taken in doing the work if the nuts are first slackened back a thread or two; the joint is then started, and if no pressure is on the part it can be opened up; if there is pressure, a turn of the nuts makes matters all right until the steam can be turned off.

Not long ago I saw an act that might have resulted in a serious accident. Several men started to overhaul a large reducing valve. The nuts had been removed from the mudhole-door bolts, the wedges were driven in, and the door joint broken, with the result that the men received a warm bath.

It is a mistake to tighten up the nuts on a joint under pressure when there are only three screws to the joint, as one of the screws may be in a dangerous condition. Not long ago a man was scalded to death through the breaking of a screw in an economizer cleaning-door joint; he was tightening it up while the economizer was working. He used an excessively long spanner and broke one bolt; the other bolt gave way under pressure, there being only two bolts to the joint. Men have been killed while tightening up the tube-caps on water-tube boilers while the boiler was under pressure.

It is also a mistake to open the bypass

of a steam trap draining a live-steam pipe through which there is no circulation of steam if there are indications that the trap is not working; the main stop valve should first be closed.

Once, after hours, I noticed that the steam trap draining the fire-pump steam pipe had water trickling from the gland. The pump was not working at the time, and, without thinking, I opened the by-pass. Water-hammer started, and before I could get out of the pump house to shut off the steam the pump valve burst.

All know of the grave danger of doing these and many other things, but we are apt to get very careless. I knew an Italian electrician who would not go near any electrical apparatus without having one hand in his pocket. He said one should never shake hands without a proper introduction, and that this applied especially to electrical apparatus.

WILLIAM GILLEAN.

Barna, Scotland.

Saving Clerical Work in Station Reports

Keeping records is the bane of many an engineer's existence. Hundreds of able power-plant operators would rather pack a drip valve near the bottom of a dirty, ill-lighted sump than to fill out half a dozen lines of a report blank after making an emergency repair, and they are not to be blamed for disliking the "old man's" red tape. But records of plant work and operation are now as much a part of the business as engine and pump surgery, and the wise engineer faces the facts instead of grumbling and puts some hard thinking into the problem of doing the clerical work as easily as possible.

Much depends upon the form of log employed and the extent to which graphic methods are utilized. Sooner or later in every plant the routine conditions become so well established that most of the events can be classified, even if they cannot be foreseen. Take the single point of service interruptions. These may come very infrequently in a well managed steam plant, or they may occur oftener than one would suspect on a large system having a number of hydro-electric stations feeding a common transmission network. The whole system may seldom be interrupted, but for legitimate or accidental reasons some part of it may frequently be temporarily out of service.

Now, the causes of such interruptions have been classified on one representative system of this kind according to letters of the alphabet, a key being placed on the daily report sheet of each station, and when any portion of the system is cut off, it is only necessary for the operator to insert the proper letter at the time of the occurrence. Thus, "A" signifies "automatic switch tripped"; "E" means "service switches held out stated time at request of consumer"; "H" indicates that there was "interruption for line work, arranged for by load dispatcher"; "J" indicates "low voltage and poor regulation," etc., there being 16 ordinary causes of trouble. This plan is so simple that it is surprising that it is not more generally used, along with other abbreviations for repairs and adjustments of individual pieces of apparatus.

Another labor-saving scheme is the plan of leaving out most of the vowels in making notes on the log. A little practice soon enables the engineer to describe events of more or less importance in surprisingly little space. Thus, "Rpd + tml auto circbkr sgnl cntct" tells just as much of a story as the long-hand sentence, "Repaired positive terminal of automatic circuit-breaker signal contact." There is a chance to take a leaf from the record book of the train dispatcher along the lines of brevity without incompleteness in improving the records of power-plant operation.

Plotting the load variations and important meter readings on a station log sheet instead of tabulating them also saves time and labor. A simple check mark on a properly calibrated cross-section scale is all that is necessary in many cases. Where the reading is fractional with respect to the scale, it may be desirable to write the figure against the check, but usually the check mark is sufficient. Recording wattmeter readings of total output of any particular service may properly be put down in figures, but there are many entries on the average station log sheet which can be plotted graphically without the slightest injury to anybody

Another place where time can be saved is in the use of constants for a given installation of equipment. The displacement of a pump should be figured once for all, and similarly, the constant quantities imposed by an engine of given size and type upon the equation by which the indicated horsepower is calculated should be determined once and filed in an accessible place rather than refigured at every occasion. Instead of writing in figures the times of starting and stopping service from different prime movers and auxiliaries, numerous plants are now utilizing the simple and effective scheme of drawing a horizontal line past the hours of operation and breaking it at shutdowns, on the same scale as the load curve.

There are many ways in which the engineer can save himself trouble without interfering with the accuracy or completeness of his records, and each plant presents a little different combination of equipment and service conditions from which the proper abbreviations may be selected.

H. S. KNOWLTON.

Newton, Mass.

Valve Locking Devices

Many accidents are due to the stop valve on an empty boiler in a battery being left open when a man was inside. By using the simple arrangement shown herewith this accident could not occur. Safety valves and doors are locked, and dangerous valves should be locked also.

In Fig. 1 *B* is a strap having a swinging arm *C*. When it is desired to prevent the valve from being opened or closed it is locked as shown. When the arm *C* is not in use it will hang down out of the way. For large valves it is good practice to make an iron arm, using it as shown in Fig. 2. The part *E* is made wide enough to prevent its being turned between the spaces in the valve handle. These suggestions are for simple locks only.

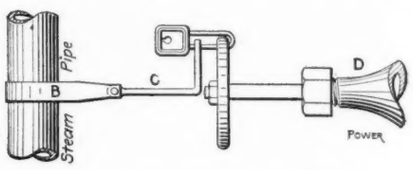


FIG. 1. LOCK FOR VALVE WHEEL

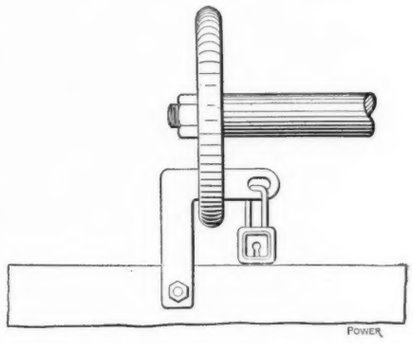


FIG. 2. LOCK FOR LARGE VALVES

JOHN THORN.

Toronto, Can.

Water in Ashpit

Reading a recent article on putting water in the ashpits recalls experiences with using screenings or washings from the culm piles in a large station with boilers having two 10x10-ft. grates each, and about an inch of forced draft in the ashpits. The boilers were hand-fired and had six doors to each grate.

When the fires were cleaned the thin layer of good fire was pushed to the back and the entire front half of the fire was burned down and dumped. The top of the back half of the fire was spread over the front grate and covered heavily, so that one would think there was no fire there at all. The draft was then put on and the back half, the remaining old fire, was burned down and

dumped. The clean front fire was then evenly spread over the grates and covered as before.

One fireman, in a hurry to get the fires cleaned as fast as the peak load dropped off, would turn the water into the ashpit before the new fire had had a good start and the steam, blowing through the fire from the ashpit, would completely deaden the fire in large spots.

This rather upholds the theory that water in the ashpit chills the fire, but it is no doubt necessary to wet the ashes in the hoppers to prevent burning them up.

As this coal was very fine and dusty, some of it would fall through the grates and collect in the bottom of the hopper and when the water was put on, the water-gas would burn out of the bottom of the hoppers, and sometimes ignite with quite a loud report.

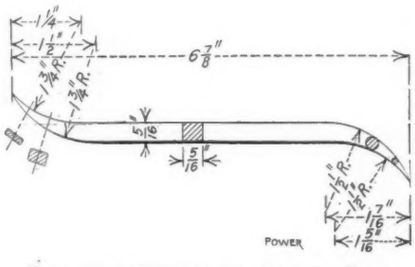
WEBSTER TALLMADGE.

Warren, R. I.

Cotter Pin Extractor

The accompanying illustration shows the shape and details of a tool used for extracting cotter pins. The pointed end of the tool is used for pulling out the pins, and the chisel-shaped end is for spreading the ends of new cotter pins after they have been put in place.

The tool is made from $\frac{5}{16}$-in. square



TOOL FOR EXTRACTING COTTER PINS

tool steel, the ends being heated in a forge, hammered into shape, tempered and then smoothed up on an emery wheel.

To properly shape the tool, first lay it out, full size, on a piece of thin tin, which can then be cut out along the boundary lines and used as a template by which to bend the piece of steel.

H. M. NICHOLS.

Kenyon, R. I.

Clearing a Clogged Blowoff Pipe

After taking down a clogged boiler-blowoff pipe several times and finding the vertical pipe clogged, I thought of another way of freeing it of its accumulation.

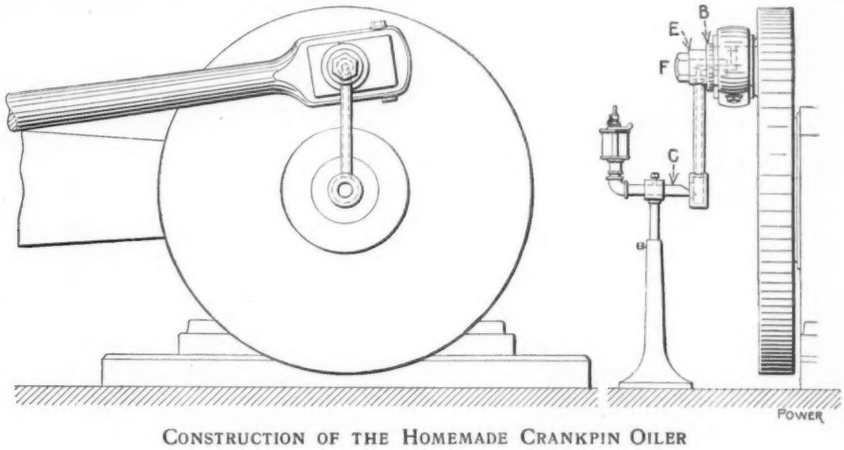
I opened the blowoff valve, put a short nipple with an elbow turned up to be used as a funnel, poured a little kerosene oil in the pipe, closed the valve and started a fire under the boiler. After firing the boiler for about five hours, I opened the valve and it blew out as freely as if it had never been clogged.

AMOS A. AMSTUTZ.

Bluffton, Ohio.

Home Made Crankpin Oiler

A simple and effective centrifugal crankpin oiler can be made according to the accompanying figure. The plate *B* forms the cap for the crankpin. Solid with this plate is the boss *E*, and the whole is held in place by the center bolt *F* and a dowel pin. The bolt, of course, has a hole extending through it and communicating with an oil hole in the pin as shown.



CONSTRUCTION OF THE HOMEMADE CRANKPIN OILER

It will be seen by the end view at the right of the figure that the quill *C* for delivering the oil may be adjusted both vertically and horizontally by means of two setscrews as shown.

C. R. MCGAHEY.

Baltimore, Md.

Used Wrench on Throttle Valve

The 6-in. throttle valve of a 750-hp., cross-compound Corliss engine began to leak, and when shutting down the engine a wrench was used on the handwheel to turn it tight. Things went along nicely, outside of a little rattle in the valve, until one night, when the night engineer started to shut down; he found that he could not shut off steam with the throttle valve and had to use one on the main header.

Upon examining the valve it was found that the disk was off, the spindle threads had been stripped and a pin had sheared. As the engine was needed, the engineer put the disk back on the stem, put a bolt through and beaded over the end on the nut. This answered for about three weeks, when the relief valve on the receiver started to blow, owing to the high receiver pressure caused by the bolt breaking. The end with the nut caught on the crank-end steam valve and twisted the stem, which allowed steam to blow through to the receiver.

The engine was stopped in time to prevent any further damage. The valve stem was heated in the furnace, the end up as far as the keyway being kept cool so as to prevent distortion of the keyway, which was all right. The end of the valve stem was gripped in the vise and, using a 24-in. monkey-wrench, the tee head was twisted back to its original position; when assembled it was found to have the right amount of lap.

The throttle-valve disk was trued up in a lathe, and a thread cut in the hole for the valve stem; a new stem was made and riveted in place, and when assembled the valve was found to be steam tight when shut off by hand. The use of the wrench was discarded and since then there has been no trouble with the valve.

THOMAS SHEEHAN.

North Adams, Mass.

Auxiliary Valve Stem

A 4-in. bypass valve is located beneath the floor of our power house, and having to open it every time the waterwheel is started, I devised a way of operating it without going below.

Taking the handwheel off of the valve stem, I filed the end of the stem square, and drilled a hole through the floor large enough to let a 1-in. pipe through. Then cutting a piece of 1-in. galvanized pipe of the required length, I hammered the burr in, and slightly dented the pipe on each side, placed it over the square end of the valve stem and ran hard babbitt metal about 2 in. deep in that end. I then drilled a ½-in. hole in the other end, and put in a ½-in. piece of round iron, 9 in. long, for a handle.

I can now open or shut the valve without trouble, and as the extra stem is slipped off after using, it is not in the way, and the floor is left clear of any obstruction.

V. C. WOOD.

Copenhagen, N. Y

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

A Pumping Problem

All of the letters in the issue of Jan. 23 on the centrifugal-pump problem were shots in the right direction, but none brought out the fundamental principles involved in the question or the reason why.

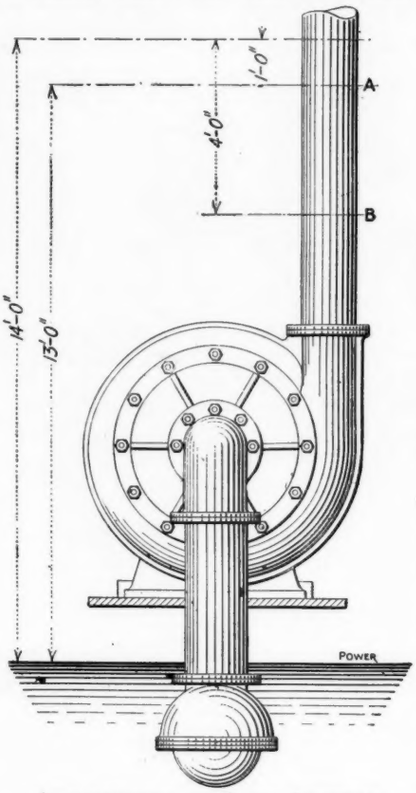
Mr. Dowd is correct when he says that all pumps do not overload. A pump can be designed that will not overload, even though the static head be suddenly and completely removed.

There should be two distinct classes of centrifugal pumps. One should be designed for variable speeds, intended for use where there are no sudden changes of static head and the speeds of the pumps are fixed according to the static heads. The other should be constant-speed pumps intended to be connected to constant-speed drivers and where the static head is liable to change suddenly. The majority of centrifugal pumps are neither one nor the other; they are hybrids, with the faults of both types and without the virtues of either.

In the following explanation, to avoid complicating the theory, I will neglect pipe friction and the resultant velocity of the water; that is, the resultant of the radial flow and the linear velocity at the periphery of the impeller. Assume a pump having impeller vanes of an angle of 90 deg. This pump has a discharge pipe run up to an indefinite height; see the accompanying figure. The pump is primed and started up and run at a given number of revolutions; the peripheral velocity of the impeller will be, say, 30 ft. per second, and the water will rise in the discharge pipe until it comes to rest at a point balanced by the 30 ft. per second, $V^2 \div 2g$, which would be 14 ft.

In reality the water would not come to rest, it would surge up and down; but to make this explanation clear I will consider that an equilibrium is established. This 14 ft. would then be the total head that the pump was capable of at the given speed. Now, suppose the pipe were cut off at *A* 1 ft. below this point, then the water would flow at a velocity due to the difference of heads, which, in this case, would be 8 ft. per second. Consider that this is a 20-in. pump and pipe, then this pump would deliver approximately 7840 gal. per minute against a total head of 14 ft. and the water horsepower would be about 27.7.

Now suppose that the pipe be cut again at *B*, a distance of 4 ft. from the point of no flow. Then the water would run off at a velocity due to 4 ft. $V = \sqrt{2gh}$ would be approximately 16 ft. per second and the pump would be delivering 15,680 gal. per minute, but the total head would not be reduced at all; it would still be 14 ft., which would consist of 10 ft. of static head plus 4 ft. velocity head. The water horsepower



ARRANGEMENT OF PUMP, SHOWING HEIGHT OF LIFT

would be just double, or 55.4. This is in exact accordance with Bernoulli's theorem—that the sum of the static head plus the velocity head will always equal the total head.

These exact conditions are merely assumed for the sake of clearness; as a matter of fact, if the friction head were considered it would simply reduce the velocity head but would add a corresponding amount to the pressure head and the total head would remain unchanged. If the resultant velocity be considered, as the flow would be increased by a lower static head the resultant velocity would be greater and the total head would be increased. Thus it is evident that not only would the amount of water be increased when the static head is decreased and the pump kept at a constant speed, but the total head, instead of being less, as claimed by some, is not decreased.

If the vanes had a backward rake there would be a tendency to reduce the total head, but if the area of passages between the vanes was large this reduction would be small and there would still be a tendency to overload when the static head is reduced.

WILL I. BETTIS.

Houston, Tex.

Measurement of Hot Feed Water

I read the articles which appeared recently on "Measurement of Hot Feed Water" and was much surprised that no mention was made of the "Lea" V-notch recorder.

The V-notch method of measuring hot water seems to be growing in favor among engineers because of its simplicity, accuracy, freedom from error due to collections of sediment and deposits of scale, its compensating feature for changes in temperature and because there are no moving parts coming in contact with the flow, except the float which operates the recorder; this is placed in a chamber by itself and is completely protected from the flow.

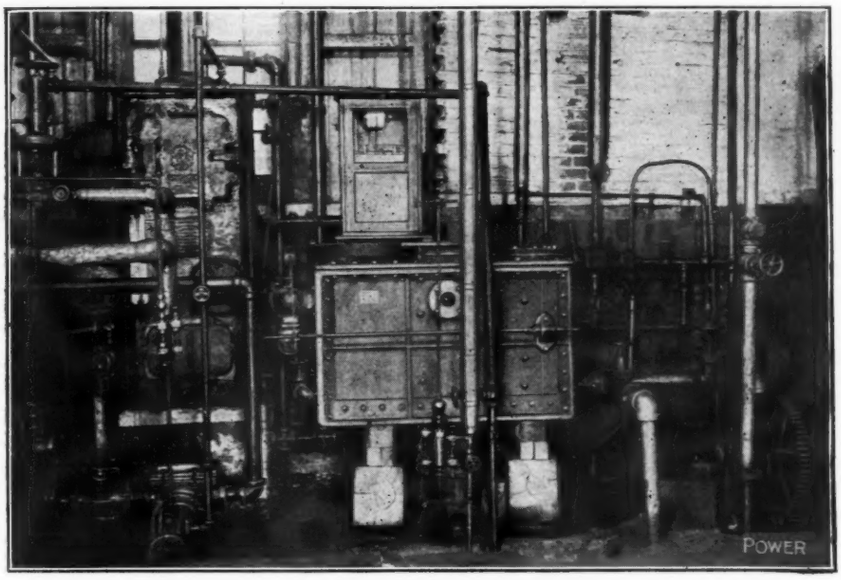
Like the venturi meter and the Pitot tube, the V-notch recorder is a continuous-flow meter. The fact that the V-notch recorder has a storage tank to contain the weir explains one reason why it is meeting with success in power plants; this storage of hot water requires a considerable interval of time to change its level, and this change of level gives an opportunity for the recording apparatus to properly adjust itself. In other words, the V-notch recorder has a dampening effect on the record of the fluctuations in the load.

The recorder is always placed on the suction side of the feed pump and hence the whole apparatus is at atmospheric, or very near atmospheric, pressure, and is readily accessible for cleaning and repairs. With the recorder is also provided a chart having rectangular coordinates which many consider an advantage because it can readily be filed and a standard planimeter may be used to measure the area of the chart and

thereby calculate the quantity having flowed through the recorder during any period of time.

As far as we know, there is no apparatus which can so readily be checked as the V-notch recorder, because by a pointer attached to the float rod in front of a scale the actual head in inches going over the weir may be seen at any time. This value may be substituted in Thompson's formula for the V-notch and the result compared with the indicated rate of flow on the calibrated drum of the recorder or on the chart record.

Some engineers feel that the weighing machines of the dumping-bucket types are preferable to the other hot-water meters because they give on a counter



A "LEA" RECORDER IN SERVICE

dial the total quantity which has flowed through the machine. If this is the only result they are seeking, such information is undoubtedly given, but in the operation of a power plant is it not very much more important to know the fluctuating condition of the load as well as the total load on boilers and turbine or engines, as the case may be?

The fireman or water-tender can by glancing at the chart see whether the rate of feed has been as constant as the load, and if not, he can exercise more care as to the regulation of the feed pumps. This one principle alone—viz., uniform rate of feed—will, I believe, be found to be one of the most important factors in obtaining a high evaporation and one which is most neglected in the smaller plants. Is it not only by such an analysis of the load as provided by a recorder chart that economical and efficient working conditions may be established and accurately checked from day to day?

ARTHUR C. JACKSON,
of the Miller Lock Co.

Philadelphia, Penn.

Copper Crosshead Shoes

The letter in POWER for Jan. 23 relative to copper-lined crosshead shoes reminds me of an experience I had in putting into operation the power plant of a portland-cement works.

This plant contained four heavy-duty Corliss engines, two simple, 24x48 in. and two cross-compound 24 and 48 by 48 in., having copper-lined crosshead shoes. During my absence one of these shoes heated (from lack of sufficient oil, probably, as the engines had only been in operation a few days) and fire flew, in spite of all the attendant could do, until the engine was stopped. According to his report, less than one minute's time elapsed between the smoke and the fire.

The copper was found to be so hard in spots that neither a file nor a chisel would take hold, and it was necessary to grind these spots off on an emery wheel. The guide was badly scored up during the accident and it was necessary to substitute babbitt metal for the copper before the engine could be operated again.

No serious trouble was experienced with any of the other copper shoes, but after three years' continuous service, the scored guide with the babbitted shoe showed almost imperceptible wear, while the other guides were worn down $\frac{1}{16}$ in. and more. On the other hand, the copper shoes were worn off less than $\frac{1}{8}$ in. while the babbitted shoe had been relined twice.

I believe that yellow brass makes the best lining for crosshead shoes, as it is better that the lining of the shoes should wear than the guide; and while babbitted shoes are too soft, the copper will be found too hard in most cases.

J. W. FOWLER.

Nashville, Tenn.

I noticed what C. L. Johnson had to say regarding the merits of the copper crosshead shoes, in the Jan. 23 issue. Copper, while very soft, or close grained, is very tough, while babbitt does not possess this quality and would have offered less resistance if it had been employed. In other words, it would have commenced to flake and "ball up" under the shoe from the effect of the grit.

LLOYD V. BEETS.

Nashville, Tenn.

What Means the Dome?

Referring to the article in POWER of Dec. 26, John Francis' comment in the issue of Jan. 30 is about correct.

There are probably but few old-timers left who fired the pigmy locomotives back in the sixties, like myself. The cylindrical part of the boiler was small and the steam space above the water line was often less than 10 in. The throttle valve was placed in the top of the forward dome to get as dry steam as possible; the second dome was available for steam if the water level was not too high, giving the advantage that would accrue from one large dome. The single large dome over the firebox soon replaced the double style, and steam pipe and throttle valve were placed in the top, just beneath the old spring balance safety valves.

E. STANLEY THOMAS.

Fremont, Ohio.

Either is Right

My attention has just been called to an editorial filler in POWER, for Jan. 2, to the effect that if one wanted to know whether the name of the Stirling boiler is spelt with an "i" or an "e," he could not find out from my paper on the Delray tests.

I wish to point out that all Stirling boilers are sterling, and that he would be right with either spelling.

D. S. JACOBUS.

New York City.

Engine Load Not Equalized

Harry H. Gordon, in the issue of Jan. 23, makes inquiry about equalization of load between the high- and low-pressure cylinders of a 14 and 28 by 36-in. noncondensing steam engine.

In the first place, if the diagrams were taken simultaneously and represent the average load on the engine, it is too large for its work, which accounts for the loop in the low-pressure diagram. Next, the engine was originally designed for a condensing engine and the cylinder ratio is too high for running noncondensing. This accounts for the long cutoff in the high-pressure cylinder, with excessive terminal drop (apparently about 40 lb.), although the engine carries so light a

load as to form a negative loop in the low-pressure diagram.

The receiver pressure is too low, and should be about 10 lb. higher for a non-condensing engine carrying 130 lb. gage steam pressure. If the receiver pressure were raised which may be done by shortening the low-pressure cut-off, it would go quite a ways toward work equalization and would also lessen the terminal drop in the high-pressure cylinder. There seems to be considerable loss of both pressure and volume between the cylinders, and the terminal pressure in the low-pressure cylinder is much lower than should result from the long cutoff in the high-pressure cylinder. This indicates leakage or excessive condensation, or both.

A cylinder ratio of about 3, a somewhat smaller low-pressure cylinder, say a 15 and 26 by 36-in. engine, would probably have been more satisfactory.

WILLIAM E. NINDE.

Syracuse, N. Y.

Repair Work Suggestions

The figure accompanying Joseph F. Pflum's letter, in the Jan. 30 issue, shows ⅞-in. studs inserted in the spokes crosswise of the fracture. The job probably would have been improved if he had drilled and tapped the rim of the wheel for the proper size studs, as shown in Fig. 1.

I once assisted in repairing a large

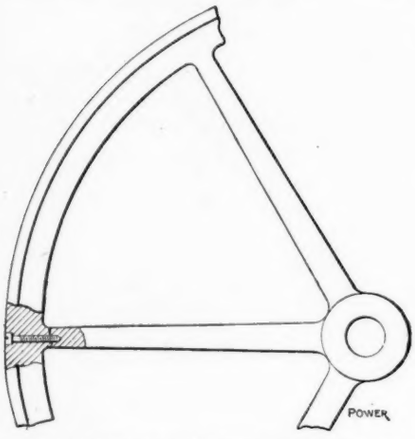


FIG. 1. SHOWING BETTER POSITION OF HOLDING BOLT

pump gearwheel which had a crack in the rim. Referring to Fig. 2 and assuming that the crack was at point *A*, we first notched out the spokes at *B* so as to afford a good bearing for the U-bolts shown at *D*, which were fitted on and turned up tight with a pair of turnbuckles.

Another method of repair which we used on smaller gears is shown at *E*, Fig. 2. We bent two heavy strips of iron, to conform to the inner surface of the wheel rim, and drilled two holes in each end of the strip so that they would come a safe distance away from the crack. We then laid them in the rim of the wheel, one on either side of the boss, if there was any, and fastened them firmly with capscrews, set up good and tight.

In case a piston rod or a driving rod is broken short off and it is impractical to weld it, a good scheme to use is illustrated in Fig. 3. Take the longer part

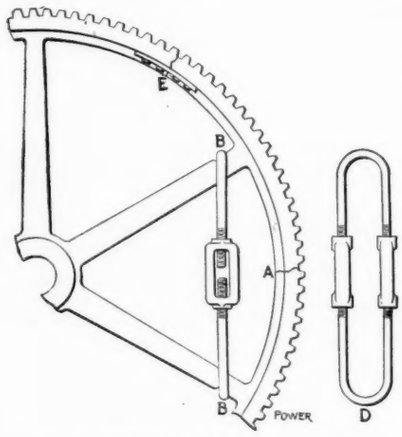


FIG. 2. METHOD OF REPAIRING GEAR WHEELS

F of the rod, and chuck it in a lathe; turn the broken end off square, drill and tap it as at *G* and fit on a new end piece *H*, which has been cut to the proper size and threaded on the end. Should there be any unevenness at the joint, the whole job can easily be trued up in the lathe, after which not only will it be

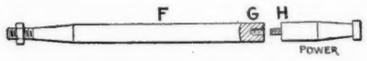


FIG. 3. METHOD OF REPAIRING PISTON ROD

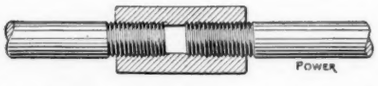


FIG. 4. METHOD OF REPAIRING ECCENTRIC ROD

hard to tell where the splice is, but the rod will run with perfect smoothness through a stuffing-box or gland.

In the case of an eccentric rod or one subjected to vibration as well as endwise pull, I would use the methods illustrated in Fig. 4. The ends are turned up and threaded. Then a piece of shafting ¾ or 1 in. larger in diameter than the broken rod and of sufficient length to give the job proper strength is drilled clear through and tapped for each end. Should the conditions demand great rigidity, a longer thread may be cut on the ends of the rod and a jam nut put on either side of the sleeve.

THOMAS M. STERLING.

Middlebranch, Ohio.

Personal Appearance

The foreword in the Jan. 23 issue is very good and much needed at this time. If the engineer of the small plant who is trying to get a deserved increase in salary would take more interest in his personal appearance as well as that of the plant, he would stand much higher in the estimation of his employer and help to better conditions.

If a supplies salesman came into your plant dressed in dirty clothes and looking as sloppy as many engineers do while on duty, it would lower your estimation of his goods beneath those of his competitors. No one realizes this better than the salesman. When an engineer goes to the office to ask for an increase or for new equipment, wearing overalls over his underwear, as many do, with a piece of greasy waste hanging from a jacket pocket and an old dirty cap and dirty hands and face, his arguments will carry but little weight because his appearance has a great effect on the strength of the arguments.

A boiler inspector's job is long, dirty; yet his appearance in the office is as good as that of the boiler salesman, and he is respected.

The engineer has a great many dirty jobs to do, but when the work is completed he can usually find time to clean himself.

J. C. HAWKINS.

Hyattsville, Md.

Central Station vs. Isolated Plant

The solicitor for the central station tells a very nice story of how much can be saved, etc., and I am very sorry to say that in some cases the engineer is unable to show that these statements are not true. Here is a case, however, which I think should show the owner of a plant of any size that there must be some saving in the isolated plant.

The largest group of buildings in this city has been served by an isolated plant for years, and when the central-station company was formed some years ago the owners of these buildings were interested in this company. In course of time a large addition was built to the building which the central-station company occupies and for which it furnishes light and power. For some reason, I do not know what, two new engines were put into the new part and a large sum of money was spent in making the engine room uptodate. Now why, if central-station power is so much cheaper and better, did they not use it in the extension?

C. L. JOHNSON.

Newark, N. J.

An interesting editorial, that, in the Feb. 13 issue, entitled "How the Central Station Got One Plant." It seems to me

that there is something to be read between the lines. Who really was the loser? It is true that the engineer lost his job, and those of the men under him. But that loss was only temporary, for it is fair to assume that at some time they would all be employed again, somewhere.

How about the employer who evidently hastily decided that the central station was the thing for him? Did he not "cut off his nose to spite his face"? His loss is probably one that will continue, even though he may not be aware of it, for it is likely that the plant could have made good if properly managed.

POWER has told engineers a lot of things concerning the proper operation of steam plants, and how to hold their own against possible invasion, and, no doubt, many engineers have profited by acting accordingly. It is now time to start a campaign of education among owners, employers and managers, and try to open their eyes.

The central station has begun its course of education with owners, but there is another side to the story which they should hear before doing as the fellow did in the editorial.

CHARLES J. MASON.

Scranton, Penn.

Uniform Boiler Laws

I was interested by the editorial in the Feb. 6 issue on the subject of "Uniform Boiler Laws," and if the American Boilermakers and Manufacturers' Association can bring these into existence it will earn the eternal gratitude of the boiler manufacturers in this country and be instrumental in providing great protection to steam users as well. I doubt, however, whether it will be possible to get concurrent legislation on the part of the states.

Although Congress could not make an enactment that would interfere with the rights of any state, it could appoint a commission to prepare a uniform law which would be known as the United States standard for stationary boilers. The adoption of this standard need not be made obligatory, and I believe that in a short time public sentiment would compel the different states to adopt it.

The present condition of affairs, due to recent state legislation as well as municipal regulations, makes confusion worse confounded for the boiler manufacturer. It also makes it a hardship for certain classes of steam users; for example, a contractor doing business in several states of the country cannot very well afford to discard the boiler on his hoisting machinery because it does not conform to the regulations governing the territory in which he has a contract. In my opinion, the only way to accomplish the desired legislation will be by establishing a United States standard.

JOHN DICK.

Meadville, Penn.

Lubricator Piping and Lubrication

In the answer to D. C. Y.'s inquiry on lubricator piping it is stated that "The lubricator pipe should not extend into the steam space of the main pipe, but should end so that the oil will run down the side of the pipe."

This is directly opposed to all accepted practice, for if the oil is allowed to run down the side of the pipe, it will not spread sufficiently to oil one-half of the frictional area in the valve chest and cylinder. On the contrary, the pipe should extend into the main steam pipe to its center and end in a slight downward curve to prevent the oil from following back on the pipe; then the temperature and velocity of the steam will cause the oil to atomize and impregnate the steam, and thus it is carried by the steam to all parts of the steam chest and cylinder.

E. H. ROBERTS.

Norwalk, Conn.

Changes Necessary

J. D. Gilmore asks, in the Feb. 13 issue, what the readers think of his indicator diagrams. For a medium-speed engine they are not bad. As to what adjustments are necessary, if the engine is running quietly, it would be well to leave it as it is. There are certain standards for indicator diagrams, such as vertical admission lines and appreciable compression.

At both ends of the cylinder the steam-valve opening occurs late. Under a heavier load the governor might correct this, but as the diagrams show approximately one-third cutoff, the arrangement of engine parts should be such as to give a free admission at this point of cutoff.

To correct this late admission there are two factors to consider, the governor and the steam valves. Block the governor into position as for lightest loads and shortest valve travel; then turn engine over, observing the steam valves. They should come line and line with the edge of the port, without opening and without lap when in extreme opening position. If there is lap, the steam connection rods can be adjusted to bring the steam valves line and line. Correct the front end first and then the back end.

If the steam valves are correct, the fault lies in the governor. To correct this, an offset key will be required that will allow the governor to advance or give greater lead. It is hard to say how much this advance should be. As it is fairly safe to assume that the engine builder keyed the governor in the proper position, the probabilities are that the steam valves will be found to be out of adjustment.

The diagrams show that compression occurs earlier at one end than at the other. This can be corrected or equalized by adjusting the length of the exhaust eccentric rod or the exhaust reach rod to give earlier closing at the former and later at the latter. After this, if it is desired to increase the compression in both ends, shorten the exhaust reach rod slightly and lengthen the connection rod between the exhaust valves by an amount twice as much as the reach rod was shortened.

J. K. MCINTYRE.

Newburgh, N. Y.

The diagrams shown in the issue of Feb. 13 by Mr. Gilmore indicate that the engine is operating under a rather heavy load. Moving the eccentric ahead on the shaft in the direction in which the engine is running will sharpen up the admission line and improve the diagrams considerably.

C. R. MCGAHEY.

Baltimore, Md.

Various Comments

I think if J. D. Gilmore will move the eccentric of his engine ahead, the diagrams will be good. The steam valves are late. There may be some other little adjustments needed, but it is hardly safe to advise until the greater fault is corrected.

My experience with gage-glasses on traps and separators is the same as that of J. W. Dickson and Edgar Altman; it is quite impossible to keep them in even when the pressure is moderate.

I think Mr. Strachan's cure for hot bearings is the most novel I ever heard of; if it cures, all right. I think that a little fine abrasive, like grindstone grit or Sapolio, will cut away the high spots and when the bearing is good the trouble always disappears.

When there is a knock, I give the box that appears to be the offender a liberal dose of oil; that will usually deaden the noise. Then I make a pencil mark across the key and gib and drive the key the width of the mark. If this is not enough it can be repeated the next day.

I have been in my present position five years and have had no trouble from hot bearings in that time. I have one 26 and 48 by 72-in. cross-compound and one 20 and 36 by 60-in. cross-compound engine running at 60 and 70 r.p.m., and doing about 2000 hp. Four gallons per day of oil, costing 14c. per gallon, with ordinary oil cups, oil these engines as well as all the auxiliaries. Does not this speak well for the man who looks after the oiling?

If Scott Norton, when punching out bolt-holes in sheet packing, will do his cutting on the end of the grain instead of the side of the board, he will find that his punches cut much better as the wood is more solid.

J. SWALLOW.

Utica, N. Y.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Cement for Leather Belts

What is a good cement for leather belts?

R. W.

Place equal parts of common glue and isinglass in a glue pot and add sufficient water to cover the whole. Let it soak for 10 hours and then bring it up to a boiling heat. Add pure tannin until the mass looks like the white of an egg. Apply warm.

Oil Switch

What is an oil switch for, and how is it operated?

M. G.

An oil switch is similar in its action to other switches, except that its contacts are immersed in a small tank of oil. It is used principally on high-tension voltage service; the large arc which would result from breaking a high-voltage line with an ordinary switch, is almost entirely eliminated by the oil which flows between the contacts of an oil switch when opened. The oil has a high electrical resistance; it is a mineral oil free from acid and water.

Sulphur Dioxide as a Refrigerant

How does sulphur dioxide compare with ammonia as a refrigerant?

F. M. M.

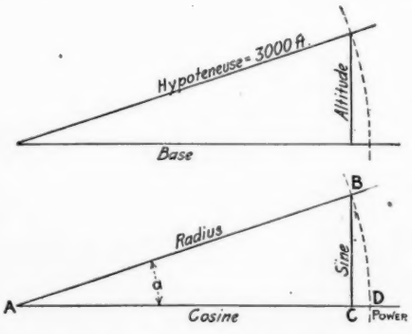
Sulphur dioxide gives a low efficiency at very low refrigerator temperatures, and requires about three times as much compressor capacity as ammonia. In tests made by Shroder and Denton, on sulphur dioxide with a condenser temperature of 80.6 deg. F. and a suction temperature of — 15.9 deg. F., the ice-melting capacity per pound of coal was 10.1 lb. and the per cent. loss due to cylinder superheating was 39.2. With ammonia having a condenser temperature of 84.6 and a suction temperature of — 10.4 deg. F. the ice-melting capacity per pound of coal was 14.5 lb. and the per cent. loss due to cylinder superheating was 22.9.

Base and Altitude

What are the base and altitude of a figure whose hypotenuse is 3000 ft. long and the angle 12 deg.? What would they be if the angle was 22 deg.?

P. J. D.

The arc of the circle in the illustration is drawn with the radius *AB*. The line *BC* dropped from the extremity of one radius perpendicular to the other radius *AD* inclosing angle *a* is the sine of that angle. The line *AC* between the center *A* of the circle and the intersection *C* of the sine is the cosine. For a given



angle, the lengths of these lines will have a definite relation to each other, and these relative lengths are given in the table of trigonometrical functions, the length of the radius being taken as unity. In the problem, if the hypotenuse is taken as the radius, the altitude will be the sine and the base the cosine.

The table gives the following values:

Angle	Sine	Cosine
12°	0.2079	0.9781
22°	0.3746	0.9272

This means that for an angle of 12 deg. the sine is 0.2079 of the radius and the cosine is 0.9781 of the radius. Since the radius or hypotenuse is 3000 ft., the base and altitude of the 12-deg. angle are

Altitude $0.2079 \times 3000 = 623.7$ *ft.*

Base $0.9781 \times 3000 = 2934.3$ *ft.*

and for the 22-deg. angle the base and altitude are

Altitude $0.3746 \times 3000 = 1123.8$ *ft.*

Base $0.9272 \times 3000 = 2781.6$ *ft.*

Low Pressure Cylinder Valves

How can the valves of the low-pressure cylinder of a cross-compound engine be prevented from slamming on their seats when running light all day, with a 2-in. vacuum on the receiver gage?

J. M.

Try raising the receiver pressure by making the cutoff in the low-pressure cylinder a little earlier.

Steam per Horsepower Hour

If the duty trial of a triple-expansion steam pump was 123,000,000 ft.-lb. per 1000 lb. of steam, what is the steam consumption per indicated horsepower-hour?

C. F.

Assuming the mechanical efficiency to be 90 per cent., the foot-pounds developed in the engine cylinders would be

$$\frac{123{,}000{,}000}{0.90} = 136{,}666{,}666 \text{ ft.-lb.}$$

per 1000 lb. of steam, or

$$\frac{136{,}666{,}666}{1000} = 136{,}666.7 \text{ ft.-lb.}$$

per pound of steam, or

$$\frac{136{,}666.7}{60 \times 33{,}000} = 0.069 \text{ hp.-hr.}$$

per pound of steam, the reciprocal of which would be the pounds of steam per horsepower-hour, or

$$\frac{1}{0.069} = 14.5 \text{ lb.}$$

of steam per horsepower per hour.

Heating the Feed Water

If the steam pressure is 90 lb. and the initial temperature of the feed water is 60 deg., what saving in fuel may be expected by heating the feed water to 208 deg. F.?

P. F. B.

To find the saving by heating the feed water a given amount, divide the difference in the total heat of the water above 32 deg. before and after heating by the total heat required to convert it into steam from the initial temperature. Multiply the quotient by 100 and the product will be the percentage of saving to be expected. In 90 lb. gage pressure or, say, 105 lb. absolute, there are 1187.2 B.t.u. above 32 deg., and water at 60 deg. F. contains 28.08 B.t.u. Therefore steam at 105 lb. absolute pressure contains

$1187.2 - 28.08 = 1159.12$ *B.t.u.*

above 60 deg. This is the amount of heat which the boiler would have to supply to make a pound of steam from the given initial temperature. Water at 208 deg. F. contains 175.98 B.t.u. Thus $175.98 - 28.08 = 147.9$ B.t.u. are supplied by the heater, saving $147.9 \div 1159.12$ of the heat required or

$$\frac{147.9 \times 100}{1159.12} = 12.76 \text{ per cent.}$$

New Pumping Engines for N. Y. City

Description of the two 18,000-000 gal. horizontal triple-expansion pumping engines recently installed at the Ninety-eighth St. station for pumping into the city main.

During 1908 it became evident that the pumping capacity of the Ninety-eighth Street pumping station of New York City would have to be practically doubled in order to meet the demand. The increased pumping capacity was made imperative not only because of the natural increase in the population of the territory served, but also because of territory being added to that already supplied.

The pumping station is situated just west of Columbus Ave. and extends from Ninety-eighth through to Ninety-seventh St. and has an extreme length of 199 ft. 8 in. and a width of 50 ft. The room in which the pumping apparatus is installed is about 81 ft. long by 50 ft. wide, the remainder of the station being occupied by the boilers and other apparatus.

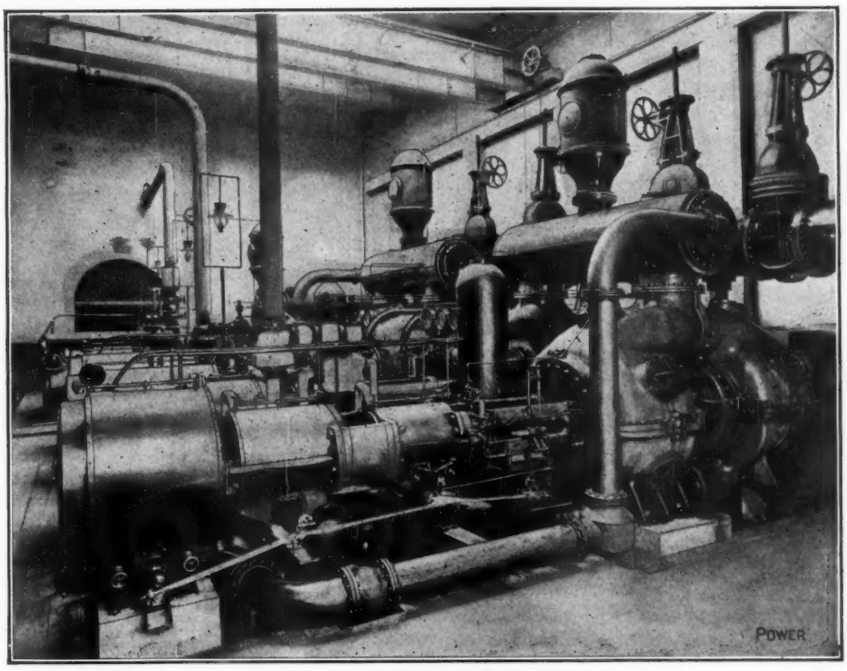


FIG. 1. GENERAL VIEW OF PUMPS

The pumping equipment, at the time the enlargment was contemplated, consisted of a Worthington horizontal high-duty compound condensing engine, installed in 1890, and two Worthington horizontal low-duty compound condensing engines, installed in 1879. The delivery of the former was 10,000,000 gal. and of the two latter, 7,500,000 gal. each, making a combined pumping capacity of 25,000,000 gal. per 24 hr.

The city desired to retain the 10,000,-000-gal. engine and replace the other two with new and larger machines. The problem was then resolved into the selection of an economical type of engine, two of which could be installed in a space 39 ft. long by 43 ft. wide (the space occupied by the two old engines). A further complication was the fact that only one old engine could be replaced at a time, the other being left in operation until the first new engine could take up its work.

As the increased capacity contemplated made it necessary to enlarge the suction and delivery mains within the station, and to so arrange them that it would be possible to deliver the water to the city mains, running parallel with Ninety-seventh and Ninety-eighth Sts., and as the station was not then equipped with a crane, although one has since been installed, it can be readily seen that there were mechanical difficulties in the way of making the change.

The specifications as prepared by the Department of Water Supply, Gas and Electricity covered two 18,000,000-gal. triple-expansion, direct-acting pumping engines, complete with foundations, condensers, primary heaters, main steam piping and auxiliary steam and water piping, supports and all other appurtenances ready for regular service. The duty of each engine was to be not less than 100 million foot-pounds of work performed, per thousand pounds of dry steam consumed by the engine and its condensing apparatus, when working under a steam pressure of 150 lb.

To meet these conditions, two Worthington horizontal triple-expansion direct-acting pumping engines were selected. These are shown erected in Fig. 1. Each engine has two 15-in. high-pressure, two 23-in. intermediate-pressure and two 38-in. low-pressure steam cylinders, and two double-acting water plungers each 34 in. in diameter with a common stroke of 24 in.

There are three steam cylinders on each side, the low-pressure cylinders being outboard and the high-pressure cylinders being nearest the water cylinders. The cylinders are placed in line with the pumps and are secured to them by heavy cradles in such manner as to make the engine self-contained so far as all working stresses are concerned. The arrangement of the piston and plunger rods is such that each steam piston or water plunger may be inspected or removed by merely taking off the head of its own cylinder, as shown by Fig. 2.

The steam valves are of the Corliss semi-rotative type, placed underneath the cylinders. This insures good drainage, as any moisture carried over by the steam does not enter the cylinders, but passes out at once through the exhaust, thus avoiding the use of drip valves or drains of any kind. The cutoff valves are placed in the high-pressure steam cyl-

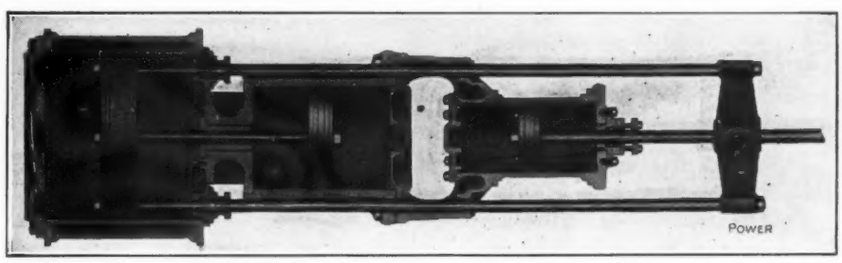


FIG. 2. SECTION THROUGH CYLINDERS

inders only and are set to cut off at from one-half to three-quarters of the stroke.

The water ends are of the outside, center-packed plunger type, having valves of the usual voluntary type, which are arranged in decks around the plungers instead of in horizontal flat decks. This construction was necessary in order to confine the length and width of the water ends to the smallest practical limit.

The condensing apparatus consists of a surface condenser placed in the discharge of each engine, the products of condensation being removed by vertical duplex double-acting air pumps, driven from the main rock shaft of each machine.

The primary heater is placed in the main exhaust line of each engine, between the low-pressure steam cylinders and the condenser. The heaters are of the straight-tube type with one end of each tube fixed in a tube head in the usual manner and the other end fixed in a floating head, which construction compensates for expansion and contraction.

DATA FROM DUTY TRIALS

	No. 1	No. 2
Duration of test, hours	24	24
Revolutions per minute	33.46	33.67
Length of stroke, inches	24.58	24.45
Piston speed per minute, feet	137.05	137.18
Steam pressure, pounds per square inch at engine	153.72	153.67
Vacuum in condenser, inches of mercury	27.42	27.39
Barometer reading, inches of mercury	30.28	29.94
Moisture in steam, per cent.	1.68	1.80
Air pump and jacket water corrected, pounds	147,077	151,203
Discharge pressure, feet	125.84	125.24
Suction pressure, feet	26.62	23.69
Distance between gage centers, feet	10.3	10.3
Total net head, feet	109.52	111.85
Total water pumped (meter), gallons	18,544,300	18,460,000
Duty per 1000 pounds of dry steam	115,519,950	113,884,400
Excess duty made above specifications, per cent.	15.16	13.88
Slip, per cent.	0.31	0.24

The accompanying table shows the results of the duty trials on the two pumping engines.

Edison Rate Discrimination Hearing

An interesting bit of information was brought to light in connection with the New York Edison rate-discrimination case at the hearing before the Public Service Commission on Feb. 29. At the previous hearings little or no damaging evidence was brought out, owing to the attitude of the company's officials in refusing to answer relevant questions and the commissioner's apparent lack of power to compel them to do so.

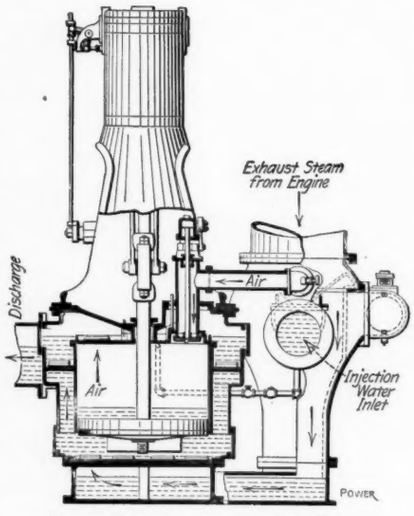
But a new factor has now been introduced into the case in the form of the New York Service Co. Its vice-president and general manager, Mr. Martin, testified that the New York Service Co. did a strictly supervising business and was in no way subsidiary to or connected with the New York Edison Co. He later admitted, however, that the principal business of his company was to investigate and report upon the cost of steam heating in private plants at the request of the Edison Co. For this service a monthly bill is rendered at cost, based upon the time of those concerned in the work. No profit is added to the bills, for, according to Mr. Martin, the company makes its profit in other ways, although just what other ways he refused to divulge.

The only plant which the New York Service Co. admitted supervising at present was that at the corner of Pine St. and Broadway. Here it operates the heating plant and buys electricity from the Edison Co. It sells the latter to the owners at cost and claims to make its profit on the heating alone. According to this, it must make such a large profit during the comparatively short heating season (to use the Edison Co.'s own argument) that it can afford to operate during the rest of the year at cost.

Twin Vertical Double Acting Air Pump

This pump has a flexible and independent control, and pistons have been substituted for the buckets, making each cylinder double acting.

The operation of the combined wet- and dry-vacuum cylinders with the auxiliaries is as follows: Water is pumped from the bottom of the condenser by the bottom end of the pistons into the bottom of the cylinders and into the annular main discharge.



TWIN DOUBLE-ACTING AIR PUMP

Air is pumped from the top of the condenser by the upper end of the pistons into the air cylinders and is exhausted into the main discharge outlet. There is a small amount of water injected into the top of the air cylinders to seal the air pistons and fill the clearance at the extreme upper stroke.

The piston rods, suction and discharge valves of both the air and water cylinders are water-sealed at all times. The suction and discharge valves of the water ends and the discharge valves of the air ends are in multiple and are automatically operated. The suction air valves, of which there is but one to each cylinder, are mechanically operated by means of a wristplate actuated from a walking-beam shaft and an automatically operated trip motion.

The steam chest is of a new design, and the short stroke and flutter of the pump is entirely eliminated. A vacuum breaker of the balanced double-valve type gives a very large opening.

This pump is manufactured by the Blake Pump & Condenser Co., Fitchburg, Mass.

Ratisal—a Substitute for a Trap

The accompanying figure shows the design of a device intended to handle water of condensation and which has been given the name "Ratisal" by its inventor, Heinrich C. Sommer, Nachfolger, Düsseldorf, Germany.

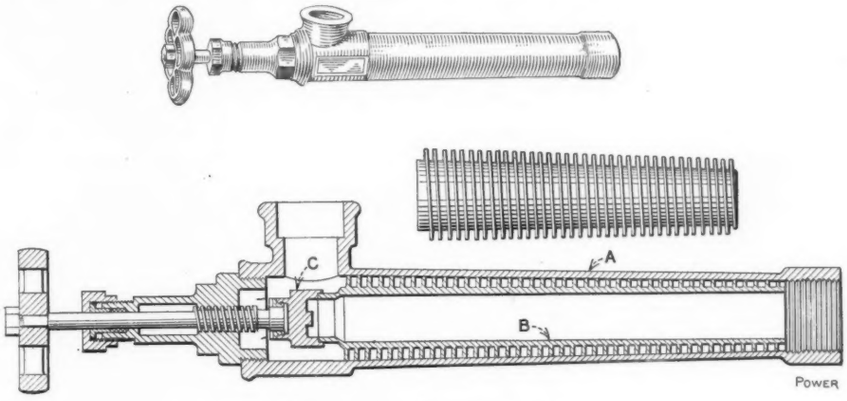
A tube-like conical shell *A* contains a removable tube *B* upon the external surface of which is formed a spiral screw as shown. During normal operating conditions the valve *C* is closed and the water of condensation is forced to find an exit through the sinuous canal of gradually decreasing cross-section formed by the spiral screw and the inner surface of the shell *A*.

As the canal is of considerable length, the frictional resistance offered to the passage of the water is almost equal to the pressure of the steam in the space being drained. By adjusting the sectional area of the canal the frictional resistance may be regulated so that the water will have any desired pressure as it emerges from the device up to within a small degree of that of the steam. For this purpose, two sizes of copper-wire spirals are supplied which may easily be wound into the screw to diminish the effective area.

If air is to be blown out of the system which the device is draining or if for any reason a temporary vigorous steam or water discharge is desired, the valve *C* is opened and a short-circuit is established through the central core of the tube *B*.

It is pointed out in the literature issued by the American sales agent for

"Ratisal," L. Scheidel, 39 Komorn St., Newark, N. J., that this device forces waste water through the drain pipe continuously and without loss of steam; the exposed or cooling surface is slight and hence the economy is high; the device can be attached to any water-producing point of a pipe or vessel containing steam, regardless of the volume of steam and the pressure. Its features are continuous operation, lack of moving parts and low cost and simplicity of installation.



DETAILS OF CONSTRUCTION

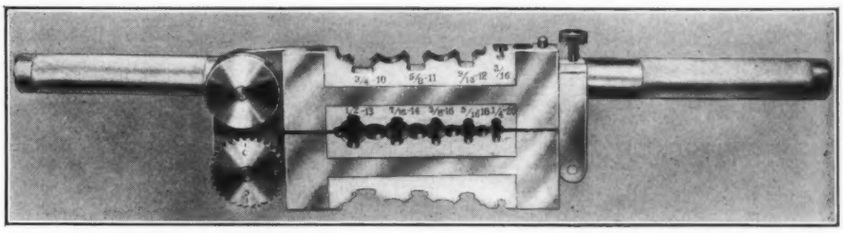
Circulating Attachment for Internally Fired Boilers

In recent issues of POWER the correspondence columns have contained letters on the dry-back marine boiler. It seems agreed that this type of boiler gives general satisfaction, and lacks but one essential qualification, namely, functional circulation. Not only does this fault cut down evaporation, but it also causes widely different temperatures to prevail at different parts of the boiler, causing severe and unequal strains and, sooner or later, leaky tubes and rivet holes.

The water occupying the space below the grate level, or center of the furnace, is entirely removed from the action of the fire and is termed "dead" water. A standard 150-hp. boiler with one furnace contains about 21,000 lb. of water. Of this, 14,000 lb. is "live" water, or water in direct contact with the heat of combustion, while 7000 lb. is "dead" water. A standard 200-hp. two-furnace boiler contains about 32,000 lb. of water; of this, 22,000 lb. is "live" water and 10,000 lb. is "dead." These proportions hold good for all sizes of internally fired boilers and it will therefore be observed that practically one-third of the total weight of water is "dead," and its temperature is low as compared with that prevailing in the "live" water.

It would seem that the one thing needful, then, is automatic circulation, independent of auxiliary boilers, pumps, etc. The patented circulating attachment which is made and furnished on all boilers of this type manufactured by John Brennan & Co., Detroit, Mich., is designed to produce this. The accompanying figure illustrates the construction of the attachment. The furnace gases impinge against the upright tubes in the circulator and the manufacturers assert that from the moment the water begins to heat, the circulation is rapid, positive and continuous over the heated surfaces, which insures a practically even temperature throughout the entire boiler.

This attachment may be applied to boilers that have already been in service.



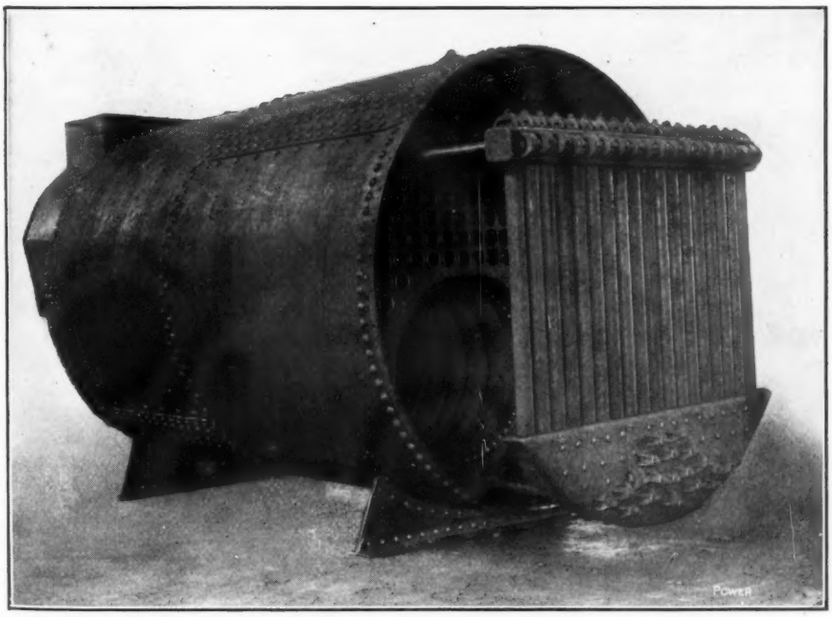
COWELL THREADER

Cowell Threader

This tool has been designed in a convenient size and is always ready to cut a thread over a range of sizes from $\frac{3}{16}$ to $\frac{3}{4}$ in. inclusive; it is illustrated herewith.

The hardened-steel removable die blocks are fitted into parallel jaws, adjustable as to distance between them. A calibrated wheel operates a cam, which changes, by a small variation, the distance between the jaws, to enable the tool to cut threads of greater or less than standard depth. The tool is 15 in. long over all, 2 in. wide and weighs 2½ lb.

After the threads have been cut the threader is opened and removed, thus eliminating the danger of making an imperfect thread when backing off. This feature also avoids the danger of damaging the dies. The threader is manufactured by the Scott-Rose Co., Marquette Building, Chicago, Ill.



INTERNALLY FIRED BOILER WITH CIRCULATING ATTACHMENT

London, it is announced, has 7875 smoke-consuming furnaces using 54 different types of apparatus. The city has so far obtained 672 convictions for smoke nuisances.

License Revoked

The government inspectors have revoked the license of the chief engineer of the "Sara Dixon," on board which a boiler blew up on the night of Jan. 18. The "Dixon" was a small stern-wheel river boat running out of Portland, Ore. The explosion occurred at Kalama, Wash., on the Columbia River. A large portion of the deck and the pilot house were blown away, killing the fireman on watch in the boiler room and the captain and first officer, who were in the pilot house. The rest of the crew escaped to the shore in the small boat. The boiler was of the standard marine firebox pattern, built in 1908, and at the last inspection it was allowed 215 lb. working pressure.

At the trial it was brought out that the pressure gage indicated only 200 lb. at the time of the explosion. The chief engineer testified that he had examined the water level only a few minutes before the catastrophe and found it to be correct. Notwithstanding his testimony, the chief engineer was found guilty of negligence and his license was revoked.

Later, the first assistant engineer was also placed on trial, but the result has not been made public at the time of this writing.

Government Examination for Engineer

The Civil Service Commission announces an examination on Mar. 20, 21, 22, to fill the position of electrical and mechanical engineer, at from $1800 to $2000 per annum, in the quartermaster's department at large, New London, Conn., and vacancies requiring similar qualifications.

The examination will consist of these subjects:

Problems in algebra, integral and differential calculus, practical calculations, designs in electrical and mechanical construction, specifications covering electrical and mechanical engineering, construction and testing of electrical and mechanical apparatus, training, experience and fitness.

The appointee in this position must be competent to draw plans and specifications for power and electrical installations, superintend the installations, and make operating tests upon them, etc. Applicants who have not had at least five years' practical experience will not be admitted to this examination. Graduation in mechanical or electrical engineering will be considered as equivalent to two years of this period.

Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for application and examination Form 1312. No application will be accepted unless properly executed, including the medical certificate, and filed with the Commission at Washington.

Corrosion of Boiler Tubes

The National Tube Co., of Pittsburg, Penn., has recently issued a bulletin on the corrosion of boiler tubes. The material contained therein has been compiled from various sources, including a series of tests made some years ago at the company's laboratories under the direction of the Navy Department, and later tests, both laboratory and service, made by several individual companies.

These tests showed very little difference in pitting under similar conditions with wrought iron and steel, although some more recent indications have favored the latter.

SOCIETY NOTES

A gratifying expression of their appreciation of the interest of their engineers in their vocation, and in their efforts for self-improvement, was furnished by the employers of the members of N. A. S. E. No. 20 of Massachusetts, who united in presenting to that association an outside spring Robertson-Thompson indicator, with five extra springs, making it available for the wide range of work which it will find in association service. With it came a reducing motion and a copy of Pray's "Twenty Years with the Indicator." The box containing it bore a plate with the inscription, "To Fitchburg Association, Stationary Engineers No. 20, from their Employers." The gift was received by the association with a keen appreciation of the spirit which prompted its sending.

Nova Scotia Society of Engineers

The regular monthly meeting of the Nova Scotia Society of Engineers was held on Feb. 22 in the Nova Scotia Technical College, Halifax, N. S. C. H. Wright, of the Canadian General Electric Co., Halifax, addressed the society on "Electric Power Development in the Maritime Provinces," the lecture being illustrated by views from the reflectroscope.

BOOKS RECEIVED

STRENGTH OF MATERIALS. By H. E. Murdock. John Wiley & Sons, New York. Cloth; 308 pages, 5x7½ in.; 153 illustrations; tables. Price, $2.

STEAM POWER PLANTS—By Henry C. Meyer. McGraw-Hill Book Co., New York. Cloth; 219 pages, 5¾x9 in.; 67 illustrations; plates; indexed. Price, $2.

TWELVE PRINCIPLES OF EFFICIENCY. By Harrington Emerson. The Engineering Magazine, New York. Cloth; 423 pages, 5x7½ in.; indexed. Price, $2.

A PRACTICAL MANUAL OF STEAM AND HOT WATER HEATING. By Edward R. Pierce. Domestic Engineering Co., Chicago, Ill. Cloth; 339 pages, 5½x8¾ in.; tables; illustrated; indexed.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES—By Harrington Emerson. The Engineering Magazine, New York. Third edition, revised and enlarged. Cloth; 254 pages, 5x7½ in.; indexed. Price, $2.

CENTRAL STATION HEATING. By Byron T. Gifford. Heating and Ventilating Magazine Co., New York. Flexible leather; 208 pages, 6x9½ in.; 42 illustrations; 50 pages of miscellaneous engineering data and tables; indexed. Price, $4.

NEW PUBLICATIONS

ENGINEERING DIRECTORY FOR 1912; nineteenth edition. The Crawford Publishing Co., Chicago, Ill. Flexible leather; 1496 pp.; 4x6¾ in.; thumb indexed. Price, $5.

This directory measures fully up to the standard established during its nineteen years of publication. The classified section contains 3850 classifications of manufacturers' products, and for those seeking a reliable uptodate mailing list for this year's sales campaign, attention is called to the following:

Jobbers of mill and plumbing and heating supplies, dealers in plumbing, steam and mill supplies in Canada; jobbers of hardware and electrical supplies, lists of manufacturers' agents and manufacturers of heating and mill supplies; railway purchasing agents, leading U. S. architects, electric light and power plants, gas companies, water-works, trade associations, and a cross index to manufactured products.

The directory also contains the names of over 6000 manufacturers producing over 4000 varieties of engineering goods, and having more than 50,000 trade or brand names.

SUPERHEATING IN MARINE PRACTICE (Die Heissdampf-Schiffsmaschine); part 2. The superheater systems and also a collection of experimental data for the calculation of the dimensions of superheater, boiler, condenser and steam-piping equipment. By Carl Fred Holmboe. Published by Wilhelm Ernst & Son, Berlin, 1912; 71 pages; 46 illustrations, with tables. Price, 3.4 marks. (81 cents).

Part 1 of this work, a notice of which appeared in POWER for Apr. 5, 1910, deals chiefly with dimensions, steam and coal consumptions and constructive details of the marine engine. Part 2 takes up superheaters in their various forms and the measurement of their heating surfaces and that of the boilers and the cooling surfaces of the condensers, and includes a reference to chimney losses and the effect of superheaters on the draft and methods of improving the latter. Considerable information is given from actual experiences and from tests of marine installations under normal conditions of operation.

The general laws of the theory of heat are mathematically and practically dwelt upon and various styles of superheaters are shown and considered.

The details of rigid and flexible pipe joints and the heat loss by piping and the nonconducting covering of the latter are gone into and a method of such covering is shown.

Note is taken of automatic stoking, and the author concludes with a summary of necessary preliminaries for the placing in service of a ship's motive power plant.

Moments with the Ad. Editor

Here is the second letter in reply to the questions asked January 23. We reprint the questions so that readers may understand the relation between them and the answers given.

1. Which ad in this week's Selling Section of POWER, describing a product you have not been previously interested in and so far as you know have no present need for, gives you the strongest impulse to investigate it immediately? Why?

2. Which ad in this week's Selling Section seems to you to have the biggest *educative* value—as described above? Why?

3. Which ad seems to you THE BEST, in every way? Why?

4. Does any ad seem to you open to improvement? If so, how?

5. Which ads did you answer?

'Way out in Seattle, Wash., they are doing some big things in a big western way. One of the large laundries of the country is located there and its chief engineer is the writer of this letter:

Accepting the invitation of the Ad Editor, I have the pleasure to reply to the questions as follows:

1. The new G. E. flow meter, as described on page 113, is manufactured by the General Electric Company, Schenectady, N. Y. The reason I am interested in this meter is because I am of opinion that every chief engineer ought to know to less than a pound, the actual evaporation of his boiler per hour; and given a competent, willing and efficient fireman, or a suitable automatic stoker, for the quality of coal he is using, he has (by taking frequent readings from his flow meter), a valuable check on the calorific value of the coal he is burning, in pounds of water evaporated per hour per pound of coal, other things being equal. Again by securing the highest evaporation and efficiency in his boiler plant, the isolated plant engineer has a better chance against the Central Station. If the meter is as reliable and accurate as its makers claim, every boiler (in the opinion of the writer) should be equipped with it.

2. The ad of the Pennsylvania Coal & Coke Corporation, or Pardee bituminous coal. Because it is a pointer to the wise engineer who will always endeavor to keep "the margin" on his side, be it ever so small. It shows how to keep the coal margin in your own favor, when by so doing you can not only retain your own business, but sometimes underbid competitors. A case in point happened only a couple of weeks ago, where a large steam laundry here lost the work of a large fleet of steamers amounting to about 30,000 pieces monthly, on an underbid of 2 cents per hundred on the total amount. They had previously held the work for some years, but their engineer had no "margin" in his department, and consequently competitors got the work at 2 cents per hundred less than the former company had been paid.

3. "4 Promissory Notes for the Engineer," seems to me to be the best in every way; because first, it is got up in an attractive form which is likely to draw a reader's attention, and second, because most engineers know the standard sterling qualities of the goods there advertised, and third the promissory notes will be duly honored, and the value promised received by the engineer who installs the valves and injector mentioned and intelligently applies the indicator to the reduction of the coal bill.

4. I do not know that I could improve on any ad in the Selling Section, but if I may suggest or perhaps state a fact which has often impressed me, and that is that there seems to be an absolute dearth in POWER of any advertisements regarding laundry machinery. Now, numberless improvements are almost daily being made in washers, extractors, centrifugals, dry-rooms, steam mangles, shirt and collar and cuff machines, all of which are expensive, and for which orders are being placed every day, by both old and new steam laundries, some of which now building are installing producer gas plants for motive power. Now, I know as a matter of fact, few engineers in laundries take the journals devoted especially to that business, as outside of their own department there is little to interest them; but many do take POWER or some other engineering journal and they feel a need of ads other than those dealing with steam traps, valves, etc.

5. I answered the following ads: General Electric Co., Pennsylvania Coal & Coke Co. and the Keystone Lubricating Co.

There is just one point there which the ad editor wishes to comment upon.

The writer asks *why* the paper doesn't carry the advertising of laundry machinery.

For the very good reason that POWER isn't a laundry paper.

As they used to say in Weber & Fields' show, "Maybe it ain't that kind of a dog."

Seriously, though, it wouldn't pay manufacturers to advertise laundry machinery in POWER because it doesn't reach enough laundries in proportion to its entire circulation.

Based upon the thought of our contributor, POWER should advertise textile machinery, printing machinery, automobiles, baby carriages, breakfast foods, union suits and so on ad lib.

Back of every industry is a power plant. The products are countless but the business of generating and transmitting power is kin to them all.

The big reason why POWER does not attempt to advertise things other than those which apply directly to its field is because it's a highly *specialized* paper. Its editorial pages tell *how*—its advertising pages show *what*.

In this day of "specialization" there is no room for that old-fashioned blanket paper which, like the Mother Hubbard, covers everything and touches nothing.

NEW EQUIPMENT

ATLANTIC COAST STATES

The Edison Electric Light Co. will build a power plant, on Massachusetts Ave., Boston, Mass. W. H. Atkins is general superintendent.

The American Thread Co., Willimantic, Conn., will construct an electrical power house below the No. 1 mill.

Valatie, N. Y., is considering the installation of a municipal electric-light and water-works system.

Weedsport, N. Y., is contemplating the installation of a municipal electric-light plant.

C. C. Hopkins, city engineer, Wolcott, N. Y., is preparing plans for a municipal water-works system. Estimated cost, $35,000.

The council of Camden, N. J., has decided to construct a municipal lighting plant, at a cost of $200,000. Levi Farnham is city engineer.

The Chester County Electric Co., Avondale, Penn., will remodel its power plant. R. B. Rhodes is general manager.

The Defender Dry Plate Co. will construct a power plant, in connection with its establishment, on Berkley Ave., Philadelphia, Penn.

Boilers, engines, dynamos and other electrical equipment will be installed in the new mechanical hall, to be constructed for the Carnegie Technical Schools, Pittsburg, Penn.

Improvements to be made in the power plant of the Pressed Steel Car Co., at the Northside Works, Pitsburg, Penn., will include the installation of two smokeless furnaces to operate boilers of 1000-hp. capacity.

The Crucible Steel Co., Pittsburg, Penn., will install two additional Playford chain grate stokers in its Park Works.

SOUTHERN STATES

The Mountain Retreat Association, Montreat, N. C., will install a 100-hp. engine and boiler, also a 50-kw. dynamo, in the power plant in connection with its establishment. R. C. Anderson is president.

J. W. Siler and W. D. Siler will install an electric-light plant, in Siler City, N. C.

The Seminole Power & Ice Co., Fort Myers, Fla., is considering the installation of a 600-hp. generating unit in its plant. R. B. Reynolds is superintendent.

The Delta Electric Light & Power Co., Greenville, Miss., is contemplating improvements to its plant, which include the installation of a 500-kw. turbo-generator, 100-kw. direct-connected exciter, switchboard and three 75-kw. transformers. Estimated cost, $25,000. E. J. Lenz is superintendent.

Bids will be received by Clarke S. Smith, United States Engineer Office, Mississippi River Commission, Memphis, Tenn., until noon, Mar. 26, for furnishing turbines, pumping sets, boilers and electric-light plant.

Henderson, Ky., is contemplating the expenditure of $25,000 for improvements to the municipal power plant and extensions to the street-lighting system.

L. B. Herrington, Richmond, Ky., and associates are considering the construction of a dam and power plant on the Dix River, near Lexington, Ky. The estimated cost of the project is $1,500,000.

CENTRAL STATES

The People's Cold Storage & Ice Co., Conneaut, Ohio, is planning to build a new ice plant.

Plans are being prepared for the construction of a municipal electric-light plant, at East Fifty-third St., Cleveland, Ohio. Estimated cost, $2,000,000. F. W. Ballard is chief engineer.

Plans have been prepared by G. C. Cummin, city engineer, Dayton, Ohio, for a new water-works system, to cost $245,000.

Pandora, Ohio, will install an electric-light plant.

The Artificial Ice & Cold Storage Co., of Indianapolis, Ind., will add automatic stokers in their power plant.

Newport, Ind., will install a street-lighting system.

Brighton, Mich., is considering the installation of a municipal water-works system.

George W. Graves, 56 Rowland Building, Detroit, Mich., is preparing plans for a one-story power plant and a one-story foundry for the Murphy Iron Works.

The installation of an electric-light plant, at Arenzville, Ill., is being considered by John G. Pratt, Virginia, Ill.

Bloomington, Ill., is contemplating the installion of a lighting and heating plant, at Miller Park.

The Ray E. Pickerel Lumber Co., Chandlerville, Ill., is considering the installation of a generator in its power plant.

The mayor of Jacksonville, Ill., has recommended the installation of a municipal electric-light plant, at a cost of $55,000.

Oakwood, Ill., is considering the installation of a street-lighting system.

The plant of the Villa Grove Electric Co., Villa Grove, Ill., was destroyed by fire, on Feb. 11. The loss is estimated at $20,000.

A power plant will be installed in the new Racine County School of Agriculture and Domestic Economy, to be erected at Rochester, Wis.

WEST OF THE MISSISSIPPI

Corydon, Iowa, will construct an addition to the municipal electric-power plant.

Fontanelle, Iowa, is considering the installation of a municipal electric-light plant.

Pierz, Minn., is considering the installation of a municipal electric-light plant.

Atchison, Kan., is considering the installation of a municipal electric-light plant, at a cost of $125,000.

Stanton, Neb., is considering improvements to the municipal electric-light plant. A new engine, boiler, steam pump and heater will be installed.

Crosby, N. D., is considering the installation of a municipal electric-light plant.

J. Barnes, of Bonner Springs, Kan., is preparing to install an electric-light plant in Orrick, Mo.

Brewer & Gore, Memphis, Tenn., will make improvements, which include the installation of a boiler and electrical machinery, to their recently purchased plant, at Imboden, Ark.

The electric-light plant, at Miles, Tex., was recently destroyed by fire.

The Missouri, Kansas & Texas Ry. System is considering the construction of a water-softening plant, at Waco, Tex. Estimated cost, $100,000. H. J. Tierney, Parsons, Kan., is mechanical engineer.

The municipal water-works plant, at Segin, Tex., will be enlarged and improved.

The Kersey Ice Co. is contemplating the construction of an electric-light plant at Kersey, Colo.

The Sawyer-Elwood Sanatorium Co. will erect a new sanatorium, at Longmont, Colo., and will require power-plant equipment for it.

The Oregon Short Line is considering the construction of an ice plant, at Nampa, Idaho.

Red Bluff, Calif., is considering the installation of a municipal electric-light plant.

The Pomona Valley Ice Co., Pomona, Calif., contemplates the erection of a large precooling plant, at a cost of $100,000.

The British Columbia Fisheries, Skidegate, B. C., will build a new cold-storage plant.

BUSINESS ITEMS

At the annual meeting of the board of directors of the Goulds Manufacturing Co., Seneca Falls, N. Y., held Feb. 26, all of the officers who have served during the past year were reëlected. In the annual report on the business of the year, a slight increase over the preceding year was shown in both the gross amount of sales and net profits.

The Wheeler Condenser & Engineering Co., of Carteret, N. J., manufacturer of surface and jet condensers, pumps, cooling towers, etc., has moved its Cincinnati office from 111 Ingalls Building to offices in the Mercantile Library Building of the same city. The new office will be in charge of Mr. Richard L. Strobridge, who was formerly connected with the Boston office of the Wheeler Condenser & Engineering Co.

The extension of the shop of the Terry Steam Turbine Co., at Hartford, Conn., is now completed and the equipment has been installed. With the former plant 1000 Terry Steam Turbines have been built on order and are in operation but with the additional space the output can now be increased 100%. We understand that the orders on hand are larger than ever before in the history of the Terry Steam Turbine Co.

James S. Abrams, of Chester, Penn., formerly representing the Brylgon Steel Casting Co. and the Baldt Steel Co., of New Castle, Del., has accepted a position with the Nelson Valve Co., Philadelphia, as special representative in Pennsylvania and vicinity, for the sale of the Nelson acid openhearth-steel castings. Mr. Abrams will make his headquarters in the Nelson Valve Co.'s Philadelphia office in the Real Estate Trust Building.

The McCord Manufacturing Co., Detroit, Mich., is distributing a new catalog which fully describes the different styles of McCord force feed lubricators for stationary and marine engines (steam and gas), for air and gas compressors, etc. The catalog is well illustrated and gives complete details of construction and operation of the McCord lubricators. It also gives particulars about the "McKim" gaskets. A copy will be sent to anyone interested on request.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

AGENTS selling steam plants can make big money selling for us; no samples; no experience is necessary. Armstrong Mfg. Co., Springfield, Ohio.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

ACTIVE AGENTS wanted to handle an engine room and water-works specialty of great merit; we will give exclusive territory; a well paying proposition for energetic man. Box 599, Power.

AGENTS WANTED to sell forced draft blowers and damper regulators; will give exclusive territory to right parties; commission on sales. Turbo-Blower Co., 30 Church St., New York.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators, traps and exhaust pipe heads; not necessary to represent entire line if interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

FOUR FIRST-CLASS electric power salesmen in city of three hundred thousand population where there are many woodworking plants, textile mills, flour mills and steel rolling mills; could use also good man versed in refrigeration and ice making. Address "Power Business," 1720 Railway Exchange, Chicago, Ill.

SALESMAN—High grade, responsible man who is practical and visits power plants regularly may arrange to represent a line of boiler specialties that offer unusual opportunities; good for at least $2500 additional income; established Michigan house; state age, record, what now handling and exact territory covered. Address Box 608, Power.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

FIREMAN or assistant engineer, 10 years' experience, wishes to make change in position. Box 605, Power.

COMPETENT FIREMAN and oiler wants to work in well equipped plant; familiar with best practice in both branches. Address Box 604, Power.

WANTED—By an operating chief engineer, fifteen years' experience, a position as salesman of high grade steam specialties; northern Ohio preferred; best references. Box 607, Power.

CHIEF ENGINEER or master mechanic wants position in plant; sixteen years' experience, turbines, Corliss and high speed engines, a.c. or d.c.; first-class machinist; best of references; state salary. Box 606, Power.

ELECTRICAL and mechanical engineer, technical graduate, wishes position as superintendent of medium sized plant; experienced with steam, producer-gas and hydraulic plants; can handle operating and commercial end efficiently. Box 602, Power.

WANTED—A position with contracting firm or with a company as engineer by man of 20 years' experience; can do erecting and repair work in first-class manner; claims to be practical expert on engines, boilers and pumps. Box 598, Power.

ENGINEER or superintendent of small electric power plant; eight years' experience, producer gas, oil or steam; employed at present, but desire change; good reasons; married, sober and capable of rebuilding plant if necessary; state salary. Address Box 581, Power.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

WANTED — 125-hp. Corliss engine; good running order; state particulars and price. Laird & Wilson Mfg. Co., Crandon, Wis.

WANTED—One 75 kw. unit, direct connected, direct current, 250 volts; give full description and price. The Turner Brass Works, Sycamore, Ill.

WANTED—A 12"x36" second hand Corliss engine; must be in first-class condition; give full description and price. Reading Engineering Works, 118 Washington Street, Reading, Penn.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1417 W. Jackson Blvd., Chicago, Ill.

WANTED—An established concern to build and sell a new stoker, on a royalty basis; device is designed on scientifically correct principles for efficiency and smokelessness; good opportunity for some live concern. Box 595, Power.

WANTED to sell at $50,000; less than cost a new and newly equipped manufacturing plant on Pacific Coast, doing a good business; large acreage, upward of 20,000 ft. floor space, railroad spur on grounds, within six miles of tide water. Address Box 593, Power.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

FIVE CORLISS vertical water leg, and sixteen Manning vertical type boilers. J. & P. Coats, Ltd., Pawtucket, R. I.

LATEST MODEL heavy duty 18x42 Brown engine, installed 1904; for sale account of removal. Box 575 Power.

ONE DUPLEX belt driven 6x8 Imperial type 11 Ingersoll-Rand air compressor. Beech-Nut Packing Co., Canajoharie, N. Y.

BOILER AND ENGINE complete working order, 35 hp., including piping, radiators, tank on roof, small steel tanks, pump, etc.; no reasonable offer refused. 123 W. 30th St., New York City.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

TWO DICK & CHURCH automatic power engines, horizontal tandem compound, 250 hp. each, size 16¼x30x18, with band wheels; both fine condition, good as new, installed 1907; price $800 each, f.o.b. cars; seen running until April 1 at Standard Oil Co., Bayonne, N. J. Address A. M. Stadler, 17 East 24th St., New York City.

SOME SECOND HAND BARGAINS—50-hp. vertical boiler, 135 lb. pressure, $275; 80-hp. vertical boiler, 110 lb. pressure, $285; 100-hp. vertical boiler, 100 lb. pressure, $300; 150-hp. vertical boiler, 125 lb. pressure, $400; 100-hp. horizontal boiler, 125 lb. pressure, $350; 150-hp. horizontal boiler, 125 lb. pressure, $500; 12"x36" Greene 4 valve engine, 10'x18" wheel, $650; 13"x34" Brown 4 valve engine, 10'x18" wheel, $550; 16"x36" Corliss 4 valve engine, 12'x24" wheel, $800; 16"x26"x18" "Fleming" Harrisburg, $850; 800-hp. National feed water heater, $300. J. F. Foster, 166 Devonshire St., Boston, Mass.

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A Promoter of Economy
A Guarantee of Accurate Gauges

It's right here before you—

The American Dead Weight Gauge Tester.

You know how important—how necessary it is—to know that your gauges are registering accurately.

It is not only a duty—it is a source of personal satisfaction and pride.

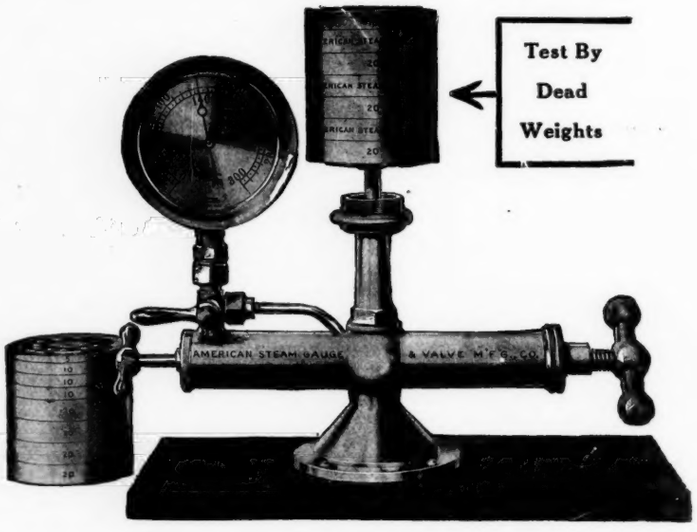
The American Dead Weight Gauge Tester tests steam gauges by dead weights and shows instantly whether or not they are registering correctly.

Consequently it prevents engineers or firemen from being misled into fuel wastes.

It is the most scientific and trustworthy device ever made for the purpose.

It has all the advantages of a mercury column—but in a smaller space. It is essentially an insurance against incorrect gauges and a real promoter of economy.

Youll be sure that the pressure indications on the gauge dial are actual facts and not near facts. The American Dead Weight Gauge Test is the sure way of testing gauge accuracy.



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Your request on the coupon herewith will bring you the catalog at once and in addition will put you on the mailing list to receive from time to time valuable and interesting literature we are publishing.

There are thousands of engineers on the American list and everyone of them wants to be kept there.

Let us have your name and address today.

SIGN AND MAIL COUPON

American Steam Gauge & Valve Mfg. Co.
Boston, Mass. 3-12-12

Send me your Pocket Edition catalog

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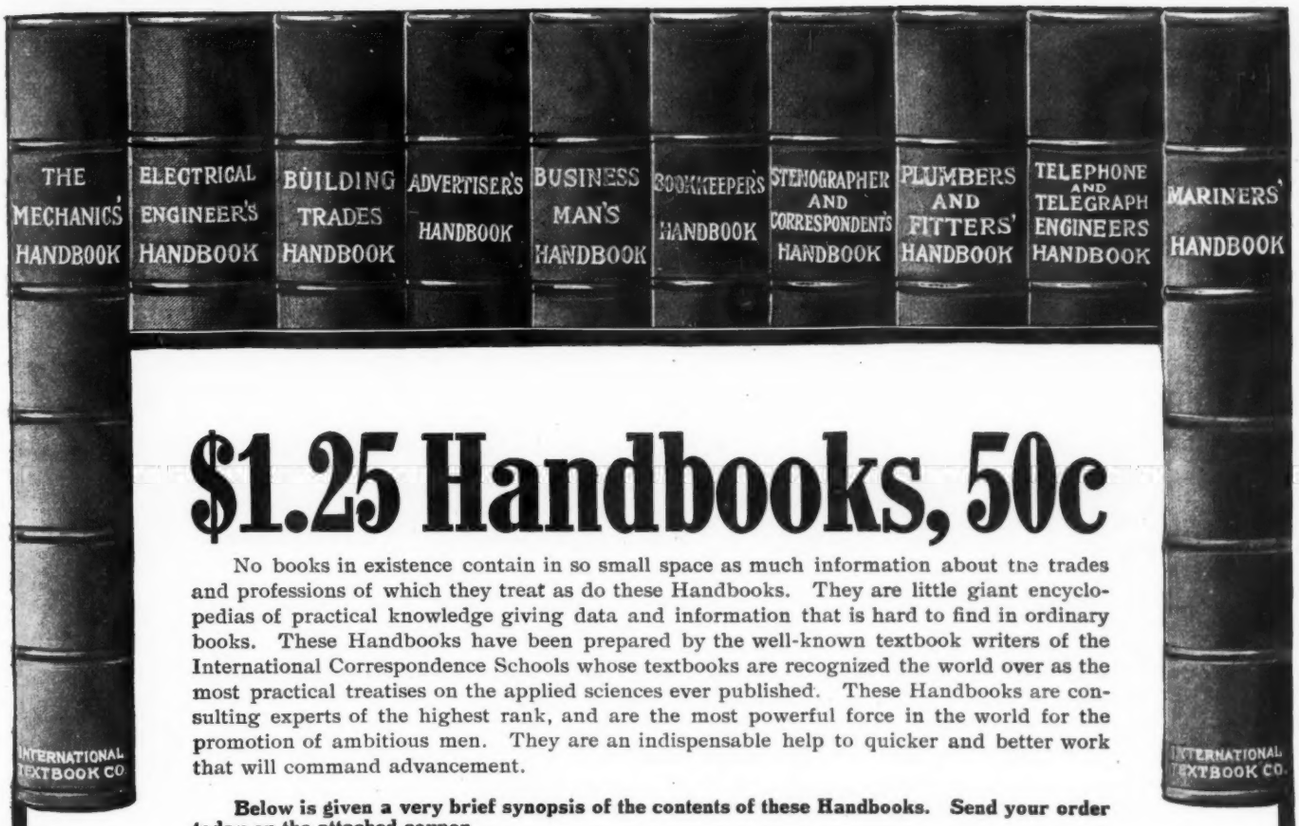
American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Sales Offices in New York, Chicago, San Francisco, Pittsburg, Atlanta, Montreal

THE BEST HOUSES EVERYWHERE SELL OUR PRODUCTS



$1.25 Handbooks, 50c

No books in existence contain in so small space as much information about the trades and professions of which they treat as do these Handbooks. They are little giant encyclopedias of practical knowledge giving data and information that is hard to find in ordinary books. These Handbooks have been prepared by the well-known textbook writers of the International Correspondence Schools whose textbooks are recognized the world over as the most practical treatises on the applied sciences ever published. These Handbooks are consulting experts of the highest rank, and are the most powerful force in the world for the promotion of ambitious men. They are an indispensable help to quicker and better work that will command advancement.

Below is given a very brief synopsis of the contents of these Handbooks. Send your order today on the attached coupon.

Mechanics'.—Tables; formulas; measurements; belting; mechanical powers; hydromechanics; strength of materials; shafting; boiler design; care of boilers; power of boilers; chimneys; exhaust heating; machine design; machine tools; slide valve; pulleys; cylinders and steam chests; pistons; gearing; transit surveying; triangulation; curves; radii and deflections; earth work; track work; electricity; etc.

Electrical Engineer's.—Mechanics; electrical units; physical and electrical properties of metals and alloys; temperature for copper wires; wire gauges; magnetism; dynamos and motors; electric batteries; alternating current apparatus; alternators; transformers; wattmeters; electric transmission: electric lamps; wiring; electric heating and welding; electromagnets; controllers; car wiring; etc.

Building Trades.—Loads and structures; strength of materials; properties of sections; strength of rivets and pins; materials of construction; footings and foundations; masonry construction; woods used in building; qualities of timbers; joinery; framing; estimating; elements of architectural design; drainage systems; plumbing fixtures; plumbers' tables; heating and ventilation; gas-fitting; etc.

Advertiser's.—How to plan and write an advertisement; type and type measurement; points on printing style; advertisement display; preparation of manuscript; proof reading; engraving and printing methods; electrotypes; matrices; advertisement illustrations; magazines; newspapers; retail, department-store, general, trade-paper, and mail-order advertising; trade marks; circulars; advertising agencies, etc.

Business Man's.—Arithmetic; tables; business forms; card systems; measures of extension; weight and capacity; time; value of foreign coins; duties on imports; bookkeeping; stenography; correspondence; postal information; financial terms; money and the money market; brokers and brokerage; patents; copyright and trade marks; corporations; business law; publicity; etc.

Mariners'.—Useful tables; logarithms; trigonometry; navigation; terrestrial navigation; celestial navigation; sailing distances; U. S. Navy; classification of war ships; organization of a man of war; naval ordnance; explosives; torpedoes; ship building; speed, tonnage, and fuel consumption; ropes; wind and weather; signals; nautical memoranda; U. S. naturalization laws; custom-house fees, etc.

Stenographer's & Correspondent's

Advice to beginners; shorthand speed; technical terms; commonly used foreign words and phrases; letters of application; punctuation; correct and faulty diction; business correspondence; typewriting; abbreviations; addressing; mailing; rates of postage; modern office methods; typewriting forms; duplicating work; etc.

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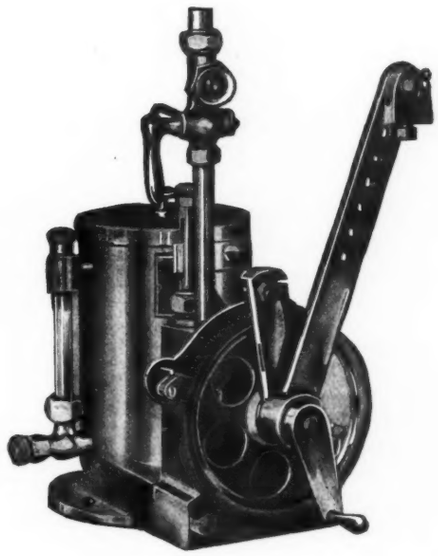

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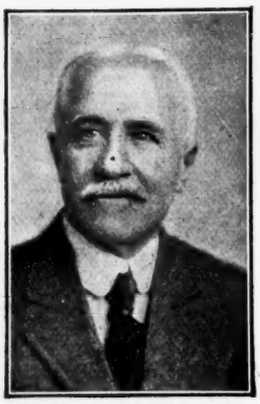

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